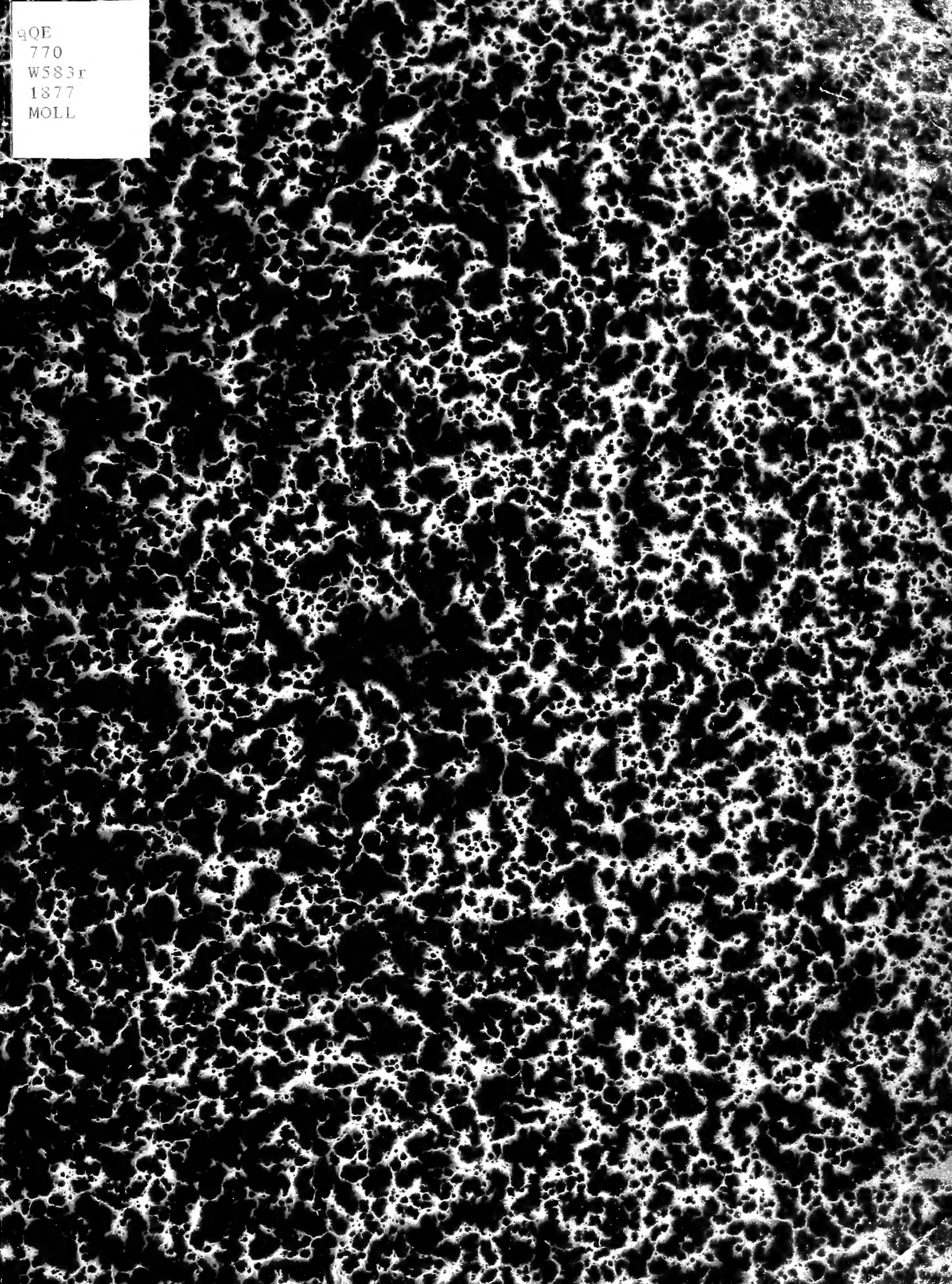


aqE
770
W583r
1877
MOLL



11 · I · 1346

SMITHSONIAN
INSTITUTION
LIBRARIES



Bequest of
S. STILLMAN BERRY

ENGINEER DEPARTMENT, UNITED STATES ARMY.

REPORT

UPON

GEOGRAPHICAL AND GEOLOGICAL

EXPLORATIONS AND SURVEYS

WEST OF THE ONE HUNDREDTH MERIDIAN,

IN CHARGE OF

FIRST LIEUT. GEO. M. WHEELER,
CORPS OF ENGINEERS, U. S. ARMY,

UNDER THE DIRECTION OF

BRIG. GEN. A. A. HUMPHREYS,
CHIEF OF ENGINEERS, U. S. ARMY.

PUBLISHED BY AUTHORITY OF HON. WM. W. BELKNAP, SECRETARY OF WAR,
IN ACCORDANCE WITH ACTS OF CONGRESS OF JUNE 23, 1874, AND FEBRUARY 15, 1875.

IN SIX VOLUMES, ACCOMPANIED BY ONE TOPOGRAPHICAL AND ONE
GEOLOGICAL ATLAS.

PART I.

VOL. IV.—PALEONTOLOGY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

TABLE OF CONTENTS.

PART I.

	Page.
CHAPTER I. GENERAL OBSERVATIONS UPON THE COLLECTIONS, AND THE PERIOD THEY REPRESENT..	5
II. CLASSIFICATION	21
III. FOSSILS OF THE PRIMORDIAL PERIOD.....	32
IV. FOSSILS OF THE CANADIAN PERIOD.....	50
V. FOSSILS OF THE TRENTON PERIOD.....	62
VI. FOSSILS OF THE SUBCARBONIFEROUS PERIOD.....	79
VII. FOSSILS OF THE CARBONIFEROUS PERIOD	96
VIII. FOSSILS OF THE JURASSIC PERIOD.....	162
IX. FOSSILS OF THE CRETACEOUS PERIOD.....	169
X. FOSSILS OF THE TERTIARY PERIOD.....	206

LIST OF PLATES.

PART I.

PLATE I.—Primordial period.

II.—Primordial period.

III.—Canadian period.

IV.—Trenton period.

V.—Subcarboniferous period.

VI.—Carboniferous period.

VII.—Carboniferous period.

VIII.—Carboniferous period.

IX.—Carboniferous period.

X.—Carboniferous period.

XI.—Carboniferous period.

PLATE XII.—Carboniferous period.

XIII.—Jurassic period.

XIV.—Cretaceous period.

XV.—Cretaceous period.

XVI.—Cretaceous period.

XVII.—Cretaceous period.

XVIII.—Cretaceous period.

XIX.—Cretaceous period.

XX.—Cretaceous period.

XXI.—Tertiary and Tertiary?

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE ONE HUNDREDTH MERIDIAN,
Washington, D. C., December 15, 1875.

GENERAL: I have the honor to submit herewith a report, in two parts, upon the paleontological results arising from the collections and examinations made during the years 1871, 1872, 1873, 1874, and 1875, in connection with geographical explorations and surveys west of the one hundredth meridian, for publication as Volume IV of the reports authorized by Acts of Congress approved June 23, 1874, and February 15, 1875.

Part I is by Dr. C. A. White, on the collection of invertebrate fossils, numbering one hundred and seventy-eight distinct species, of which fifty-four are new to science.

A preliminary report, with descriptions of new species, by the same author, was, with your sanction, published in December, 1874, the substance of which is embodied in the present volume.

The attainments and the experience of Dr. White in this branch of science are a guarantee that his work has been well done.

Part II is comprised of a similar treatment of the vertebrate fossil collections, by Prof. E. D. Cope, who has given to this subject years of study. Professor Cope was connected with the expedition during the season of 1874, in which he made collections himself, and, in addition, was enabled to prosecute geological researches. A portion of his results were published in preliminary form in a "Report upon the Vertebrate Fossils discovered in New Mexico, with description of new Species," November 28, 1874; and a "Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, collected in 1874," April 17, 1875. His geological deductions appear in my annual report, Appendix LL, Annual Report of the Chief of Engineers, 1875.

Several members of the expedition not engaged upon paleontological work have made collections of interesting specimens, evincing a hearty co-operation in this as well as other allied branches of the survey.

The whole number of specimens have become the property of the War Department, and will be carefully preserved.

The plates illustrating the invertebrate fossils were drawn by Mrs. H. M. Martin, of Albany, N. Y., and C. K. Worthen, of Warsaw, Ill., and engraved and printed by Julius Bien, of New York City. The vertebrate fossil plates have been prepared from the natural objects, engraved and printed by Messrs. Thomas Sinclair & Son, of Philadelphia.

A merited recognition is hereby tendered to all those who have contributed to the results as shown by this report.

Very respectfully, your obedient servant,

GEO. M. WHEELER,
Lieutenant of Engineers, in charge.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, United States Army.

PART I.

REPORT

UPON

THE INVERTEBRATE FOSSILS COLLECTED IN PORTIONS OF NEVADA, UTAH,
COLORADO, NEW MEXICO, AND ARIZONA, BY PARTIES OF THE
EXPEDITIONS OF 1871, 1872, 1873, AND 1874.

BY

CHARLES A. WHITE, M. D.

COMPRISING

CHAPTER I.—GENERAL OBSERVATIONS UPON THE COLLECTIONS
AND THE PERIODS THEY REPRESENT.

II.—CLASSIFICATION.

III.—FOSSILS OF THE PRIMORDIAL PERIOD.

IV.—FOSSILS OF THE CANADIAN PERIOD.

V.—FOSSILS OF THE TRENTON PERIOD.

VI.—FOSSILS OF THE SUBCARBONIFEROUS PERIOD.

VII.—FOSSILS OF THE CARBONIFEROUS PERIOD.

VIII.—FOSSILS OF THE JURASSIC PERIOD.

IX.—FOSSILS OF THE CRETACEOUS PERIOD.

X.—FOSSILS OF THE TERTIARY PERIOD.

LETTER OF TRANSMISSION.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE ONE HUNDREDTH MERIDIAN,
Washington, D. C., June 10, 1875.

SIR: I have the honor herewith to transmit my final report upon the invertebrate fossils collected by the exploring parties under your command during the years 1871, 1872, and 1873.*

The collections were placed in my hands in July, 1874,* and I at once commenced a critical examination of them, followed by the work of preparing the whole for publication; which work I have continued uninterruptedly to the present time. A preliminary investigation of these collections showed that quite a large proportion of the species were new to science, and, for the purpose of securing to your expedition due credit for priority of discovery, I wrote out descriptions of the new species then recognized, and sent them to your office, with the request that they be immediately published, for the purpose of securing the object named. This publication was made from the Government Printing-Office in December, 1874, and is the one referred to in the synonymy accompanying a republication of those species in this final report, together with additions and illustrations. Another object of this preliminary publication was the announcement of important geological conclusions from paleontological evidence. Among the most interesting of these may be mentioned the distinct recognition of the fauna of the Canadian period in Nevada and Utah; that of the Trenton period in Utah and New Mexico; and that of the Subcarboniferous period in Arizona, Nevada, and Utah.

Besides the new species described in the preliminary report, a full

* Collections of 1874 have since been placed in my hands for investigation, and the results have been incorporated into the following report.

examination of the collections has shown that a few others are also new. Descriptions of these form a part of the present report, with which they will be published for the first time. The whole number of species recognized in the collections and described or noticed in this report is one hundred and eighty-two, of which fifty species were new.

As I have not been personally engaged in any of the field-explorations, my report is necessarily a paleontological one only, confined to a zoölogical description and classification of the invertebrate fossils, a reference of them to geological periods already well established, and a discussion of the character of the evidence afforded by the fossils upon which such reference is made.

My especial acknowledgments are due to those able paleontologists, Messrs. F. B. Meek and R. P. Whitfield, for generous counsel and assistance, and to Prof. Joseph Henry, Secretary of the Smithsonian Institution, for extending to me freely all the facilities possessed by that Institution to aid me in the work.

I am, sir, your obedient servant,

C. A. WHITE.

First Lieut. GEO. M. WHEELER,
Corps of Engineers, U. S. Army,
In Charge of Geographical Explorations and
Surveys West of the One Hundredth Meridian.

CHAPTER I.

GENERAL OBSERVATIONS UPON THE COLLECTIONS AND
THE PERIODS THEY REPRESENT.

The critical investigation of fossils collected in newly-explored regions, distant from those in which the stratigraphical relations of the rocks have been accurately determined, especially if the relative position of the strata of those regions has been obscured by disturbance, it is often difficult and sometimes impracticable to assign each collection to its proper geological horizon. The difficulty is greatly increased to the paleontologist if he must prepare his report before those of the field-geologists are available, or if he has not himself visited the regions in question and obtained by personal observation a knowledge of the strata and their relative positions.

This difficulty has been met in the present instance, so far as any person could do it, by Mr. G. K. Gilbert, geologist of the expedition, by whose patient and clear oral and epistolary explanations I have greatly profited. If the collections were abundant in every case, it would be a comparatively easy task to assign them to their proper horizons; but it is often necessary to make some such assignment of a meager and uncharacteristic collection, or to pass it by in silence. This alternative has been presented to me in some instances by the collections that form the basis of this report; and I have chosen to make some assignment of them in all cases according to the best evidence presented, indicating at the same time such doubts as I have entertained.

The accompanying table of the subdivisions of geological time, which are more or less familiar to American geologists, is introduced here for the purpose of showing at a glance what periods and epochs are represented by the fossils of the collections, as well as the relative positions of the strata from which they were obtained. The names of the periods are those used by Dana in his new *Manual of Geology* (1874), and will be found to differ slightly from those formerly in use.

GENERAL OBSERVATIONS.

Table of the subdivisions of geological time.

AGES.	PERIODS.		EPOCHS.
Cenozoic.	*TERTIARY.	PLIOCENE. MIOCENE. EOCENE.	
Mesozoic.	* CRETACEOUS.		
	* JURASSIC.		
	TRIASSIC.		
Carboniferous.	?* PERMIAN.		
	* CARBONIFEROUS, OR COAL-MEASURES.		Upper Coal-Measures.
			Middle Coal-Measures.
			Lower Coal-Measures.
	* SUBCARBONIFEROUS.		Chester Limestone.
			Saint Louis Limestone.
			Keokuk Limestone.
			Burlington Limestone.
Devonian.	CATSKILL.		
	CHEMUNG.		
	HAMILTON.		
	CORNFEROUS.		
Upper Silurian.	ORISKANY.		
	LOWER HELDERBERG.		
	SALINA.		
	NIAGARA.		
Lower Silurian.	* TRENTON.		* Cincinnati.
			?* Utica.
			Trenton.
			Chazy.
	* CANADIAN.		* Quebec.
			Calceiferous.
	* PRIMORDIAL.		* Potsdam.
			Acadian.
ARCHÆAN.			

* The presence of the asterisk indicates that the period or epoch, as the case may be, is represented by fossils in the collections.

LOWER SILURIAN.

The Lower Silurian age is represented in these collections by fossils referable to all three of its periods, namely, the Primordial, Canadian, and Trenton.

PRIMORDIAL PERIOD.

The collections contain fossils of the Primordial period that were obtained in Western Utah, Southeastern Nevada, and Western Arizona, all of which are probably referable to the Potsdam epoch of that period. The most conspicuous feature of the fauna of the period, as represented by these collections, consists in the preponderance of the Articulate over all other forms of life, and which is represented by Trilobites alone, with the probable exception of the tracks described on a subsequent page. This apparent preponderance, however, is likely to be greatly modified by future discoveries.

The genera of Trilobites which these localities have afforded are *Olenellus*, *Conocoryphe*, *Agnostus*, and *Asaphiscus*; the latter being a new genus, recently proposed by Mr. F. B. Meek, probably allied with the *Asaphidæ*, while the others, as well as the geological horizon they are understood to characterize, are well known.

The discovery of two species of *Olenellus* at Pioche, Nev., is especially important and interesting, since that genus has hitherto been regarded as distinctively characteristic of a well-defined Primordial horizon in America. The interesting nature of the discovery is increased by the fact that, in their general characteristics, these two Nevada species of *Olenellus* respectively represent two other well-known species of that genus similarly associated in strata of the same period in Vermont and Canada. While all the other strata herein referred to the Primordial period have been so referred almost wholly upon paleontological evidence, the Tonto shale of the Grand Cañon of the Colorado River has been referred to that period by the geologists of the expedition largely upon stratigraphical evidence. The only indications of life that these last-named strata have afforded to the collections consist of two species of *Cruziana*, besides the tracks that have just been referred to. It is true that the presence of *Cruziana* in those strata does not prove their Primordial age; but, as such forms are rarely found in strata of other periods,

they may be regarded as adding considerable weight to the conclusions drawn by the field-geologists from other data. As these plants were the only recognizable species furnished by those strata, holding as they do so important a stratigraphical position, I have added descriptions of them to the others, although it was originally proposed that this report should be confined to invertebrate fossils alone. The existence of strata of the Primordial period at several localities in the Rocky Mountain region has been heretofore announced by different explorers; but the discoveries made by the Explorations West of the One hundredth Meridian constitute a material addition to our knowledge of the rocks of that period in the western part of the continent.

CANADIAN PERIOD.

Small collections made at a few localities in the House range, Western Utah, and in the Schell Creek range, Southeastern Nevada, I have referred to the Canadian period. The collections are not only small, but they comprise in all only twelve species. A part of these, however, are regarded as quite characteristic of the Quebec epoch of that period, to which I have assigned them with very little hesitation. Small as they are, these collections present a much greater zoölogical diversity than those of the Primordial period do, and there is not among them that preponderance of one zoölogical type over the others that has been mentioned as occurring among the collections of Primordial fossils, which consist very largely of Trilobites. The subkingdoms *Protozoa*, *Radiata*, *Mollusca*, and *Articulata* are all represented among the fossils referred to the Canadian period; the species and higher groups to which they belong being compactly shown in the systematic table on a following page. Among the more important of the characteristic forms of this period contained in the collections, the species of *Phyllograptus* deserves especial notice as being the first species of the genus yet discovered in the Rocky Mountain region, and also because the genus is regarded as peculiarly characteristic of the Quebec epoch. The discovery of strata of this period in Nevada and Utah is important from the fact that, with the exception of Professor Bradley's discovery in Idaho, their existence throughout the great Rocky Mountain region was heretofore unknown.

The discovery derives additional interest also from the fact that the period as such, and as distinct from the Primordial on the one hand and the Trenton on the other, has not, until lately, been fully recognized.

So far as known to me, neither the Calciferous nor Chazy formation of this period has been recognized in connection with the Quebec strata referred to, nor indeed anywhere in the Rocky Mountain region. It is too early to say or suggest what bearing this fact may have upon the opinion understood to be entertained by the Canadian geologists that the Quebec strata are deep-sea representatives of those of the Calciferous and Chazy formations.

TRENTON PERIOD.

The localities at which fossils belonging unquestionably to the Trenton period have been collected are Silver City and Upper Mimbres Mining Camp, N. Mex. A few other species have been collected at other localities in Arizona and Nevada, which localities are more specifically designated in connection with descriptions of the species on following pages. These species I have also referred to the Trenton period, but the intrinsic evidence they afford as to their stratigraphical position is not so entirely satisfactory as that presented by the collections from the two first-named localities. Besides all these, four species of Graptolites were collected from partially metamorphosed shale near Belmont, Nev. No other fossils were found associated with the Graptolites that might aid in indicating their exact stratigraphical position; but I have referred them provisionally to the same period with those already mentioned.

As regards the epochs of the Trenton period to which the fossils of these localities respectively belong, those from Silver City and Upper Mimbres Mining Camp are referred without hesitation to the Cincinnati epoch. This is done not only because of the general similarity of faunal characteristics, but also because of the identification of four species from the strata there that are characteristic ones of the strata of that epoch at the typical localities. The four species referred to are *Favistella stellata* Hall, *Strophomena filitexta* Hall, *Orthis biforata* Schlotheim (var. *lynx*), and *O. occidentalis* Hall.

Associated with these, there are some other species that, if not identical with associates of those species just named elsewhere, are very closely allied to them. Indeed, it is worthy of remark that there is so large a proportion of the species here referred to the Trenton period that are very closely allied to well-known species, and yet present such minor differences from typical forms, that I have felt obliged to append an interrogation-point to the names of the species I have referred them to. The Graptolites probably belong to the Utica epoch of the Trenton period, and I have made that provisional assignment of them.

Two of the Nevada species, *Graptolithus ramulus* White and *G. hypniformis* White are allied to two species, *G. ramosus* Hall and *G. Whitfieldi* Hall, that are found in the shales at Norman's Kill near Albany, N. Y., the exact stratigraphical position of which shales has hitherto been in doubt. One, *G. pristis* Hall? (not Hisinger), is apparently identical with a species from the Utica slate of New York; the other Nevada species is probably identical with *G. quadrimucronatus* Hall, the type-specimens of which were obtained from strata of the Utica epoch near Lake Saint John in Canada. While the exact stratigraphical position of the shales at Norman's Kill has not yet been demonstrated, the strata referred to at Lake Saint John are, upon published evidence, referred without hesitation to the Utica epoch. I am not aware that any species found in strata of that epoch at the last-named or at any other locality are identical with any found at Norman's Kill; but the relations of our Nevada species of Graptolites are very close with some of those found at both of the eastern localities just mentioned. It does not seem improbable, therefore, that this far western locality may be found to furnish important evidence of the equivalency of the strata at Norman's Kill with the Utica slate. (See note at end of chapter.)

It is not unfrequently the case that Graptolites constitute the only organic remains found in shales of Silurian age. This is doubtless due to the fact that the physical conditions of the sea, in which that kind of sedimentary material which now constitutes the shale was deposited, were favorable to the existence of such forms of life, and at the same time made the habitat an uncongenial one for other forms. The fact, therefore, that the Belmont shales have furnished almost no other fossils besides Graptolites is

not remarkable; but it is worthy of remark that the collections from Silver City and Upper Mimbres Mining Camp, with the exception of one Conchifer, contain only arthropomatous Brachiopods and corals; the molluscan classes *Polyzoa*, *Gasteropoda*, and *Cephalopoda*, and the whole subkingdom *Articulata*, being unrepresented. The corals belong to families common in strata of that age, namely, *Favositidæ*, *Cyathophyllidæ*, and *Thecidæ*; but the Brachiopods, with the exception of one, *Rhynchonella*, all belong to the family *Strophomenidæ*.

Peculiar interest attaches to this discovery of strata of the Trenton period in New Mexico, Nevada, and Arizona, as well as to the discoveries concerning the other Lower Silurian periods, from the fact that so little has hitherto been known of their existence in that part of North America. Indeed, with the exception of the discovery of strata of this period by Jenney in Western Texas, and that of a similar one by Dr. G. G. Shumard in Southern New Mexico, I am not aware that the existence of any besides those here announced has been recognized in that part of the continent.

UPPER SILURIAN.

The collections contain no fossils of Upper Silurian age, nor has the existence of any strata of that age in the region over which the explorations have extended been ascertained, as far as I am aware.

DEVONIAN.

Among the collections are a few fossils, the locality for which is given as "between San Antonio and Silver Peak, Nevada."

All of them are too imperfect for satisfactory specific description; but, judging from their general characters, they seem to be of Devonian age. The genera, so far as they are recognizable, are *Favosites*, *Acervularia*?, and *Zaphrentis*. There are also some fragments, probably of *Atrypa reticularis*, and part of an undetermined Trilobite.

CARBONIFEROUS.

Nearly half of all the species contained in the collections are referable to the Carboniferous age, mainly to its middle period. Among them are some very characteristic fossils of the Subcarboniferous period; but the Permian has only doubtful representation.

SUBCARBONIFEROUS PERIOD.

The physical conditions that prevailed during the Subcarboniferous period over what is now the North American continent were quite various; but the rocks of the period possess general distinctive characters in their fossil fauna, by means of which they may be separated with little difficulty from those of the next succeeding period. It is in the valley of the Mississippi that they are most characteristically developed, and where five distinct formations, marking as many epochs, are found. The names of these formations in the ascending order are the Kinderhook group, Burlington limestone, Keokuk limestone, Saint Louis limestone, and Chester limestone. Each formation has its own characteristic fauna; but through all of them a few species are continuous, even into the strata of the next period, the Carboniferous. Taking these Subcarboniferous formations together as the standard for the group, it has been found more or less difficult to recognize their respective equivalents among the rocks of the same period, either eastward or southward from that region, or, at best, the order of succession is nowhere so well shown as it is in the region referred to. In the Rocky Mountain region, it has been found that there is, at many localities, a greater or less mingling of Subcarboniferous with Carboniferous types; but at quite a number of localities, collections have been made that are regarded as distinctively Subcarboniferous. Only a very few of these collections, however, exhibit a fauna clearly referable to any particular one of the formations of the period that have just been named. Perhaps the most remarkable of the collections of this character is the one made by Professor Bradley in Idaho, the fossils of which Mr. Meek has found to be strikingly characteristic of the Saint Louis limestone as developed in some parts of Indiana.

The collections of the expedition contain fossils from only three localities that I have definitely referred to the Subcarboniferous period. These localities are Mountain Spring, Old Mormon road, Nevada; Ewell's Spring, Arizona (upper horizon); and a place below Ophir City, Utah. The collection made at the first-named locality is the most characteristic and important one of all, and is referred to the horizon of the Kinderhook formation, to which horizon it is not improbable the others also belong. As the recognition of distinct epochs of the Subcarboniferous period in the Rocky Mountain

region is a matter of considerable importance, I give the following detailed statement of the relations of these fossils to the typical fauna of the period, and especially to that of the epoch to which I have referred them. It is well known that in America several species of fossils are known to range through all the formations of the Subcarboniferous into those of the Carboniferous period, especially into the limestones of the latter. The discovery of any of these species alone in any given strata would not, therefore, enable us to refer the strata containing them to one of these periods rather than the other. On the other hand, certain genera occur in strata of each one of these periods that are not known to occur in the other, in which latter case the generic character becomes of greater value than the specific in the former. It is upon evidence of the latter kind that I have referred the fossils of the three localities named to the Subcarboniferous period.

The following list contains the names of the genera represented in the collections from those localities :—

<i>Favosites.</i>	<i>Syringopora.</i>
<i>Granatocrinus.</i>	<i>Zaphrentis.</i>
<i>Platycrinus.</i>	<i>Productus.</i>
<i>Actinocrinus.</i>	<i>Hemipronites.</i>
<i>Strophomena.</i>	<i>Orthis.</i>
<i>Spirifer (Syringothyris type).</i>	<i>Spirigera.</i>
<i>Conocardium.</i>	<i>Spirifer (Trigonotreta type).</i>
	<i>Terebratula (Dielasma).</i>
	<i>Enomphalus.</i>

Those genera of the left-hand column are not known to occur in strata of later date than the Subcarboniferous, while those of the right-hand column are known to range both above and below it. The generic value of the latter genera in this case is only to add weight to the evidence afforded by the others, which is of itself, however, very decisive. Here are seven genera, that are known to occur in Subcarboniferous strata elsewhere, but are known in no strata of later date; and as they are found at the localities named associated with types peculiar to the Carboniferous age, the propriety of referring the species which represent those genera in the collections to the Subcarboniferous period seems unquestionable.

Although I entertain no doubt of the Subcarboniferous age of the fossils from the locality below Ophir City and the one at Ewell's Spring (upper horizon), I am not able to assign them definitely to either of the epochs of that period that are represented by the formations before named in the Mississippi Valley and elsewhere to the eastward of that region. The case is far different, however, with the collection from the Mountain Spring locality, which I refer without hesitation to the Kinderhook group.

This reference is made in consequence of the identification of no less than five of the species known to exist in rocks of that epoch in the States of the great valley and eastward. The following is a list of those species, together with the localities that furnished either the types or authentic specimens:—

Strophomena rhomboidalis Wilckins.—Kinderhook group, Burlington, Iowa.

Spirifer (Martinia) peculiaris Shumard.—Kinderhook group, Missouri and Iowa.

Spirifer centronata Winchell.—Waverly sandstone, Cuyahoga Falls, Ohio.

Spirifer (Syringothyris) extenuatus Hall.—Kinderhook group, Iowa and Missouri.

Terebratula (Dielasma) Burlingtonensis.—Kinderhook group, Burlington, Iowa.

Associated with these and other species at Mountain Spring, there is a small *Productus* that I have identified with *P. parvus* Meek and Worthen, the type-specimens of which were obtained from the Chester limestone of Illinois. This might seem to throw some doubt upon the proper identification of the strata at Mountain Spring with the Kinderhook group, were it not for the fact that other species of *Productus* are known to range through the whole Carboniferous series. Indeed, more species of this genus are known to have this great range than of all other genera of invertebrates put together.

It is a well-known fact that crinoidal life was eminently characteristic of the Subcarboniferous period; but, in the Mississippi Valley, it is the Bur-

lington and Keokuk limestones that are more especially characterized by a great preponderance of these forms. Although some crinoidal remains exist in those Subcarboniferous strata that have been discovered in the Rocky Mountain region, in none of them have they been found in so great profusion as they exist in the two formations in the Mississippi Valley that have just been named. In this respect, the collections from those western localities accord more nearly in faunal characteristics with the other three formations of the Mississippi Valley series.

It could not be expected that collections of Subcarboniferous fossils so meager as those made by the expedition are should afford any very complete indication of the relative prevalence in that region of the different forms of marine life of the period; but it may be well to note that they contain no remains of fishes, no Articulates, and no Cephalopods, arthropomatus Brachiopods being the prevailing forms. Such deficiencies as those noticed are, however, not uncommon in much larger collections from typical Subcarboniferous strata.

CARBONIFEROUS PERIOD.

The accession, in the Carboniferous age, of the conditions necessary to the formation of coal was not simultaneous in all those parts of North America over which deposits of that age were made; nor were these conditions sooner or later co-extensive with all parts of the area in which those deposits exist, not even with those of the Carboniferous, or so-called Coal-Measure, period. It is also known that these conditions, even during the period of their greatest prevalence, occasionally ceased by shifting elsewhere, and were resumed again; alternating thus with conditions similar to those that prevailed at the beginning of the age, before the first coal-deposits were formed. In what are now portions of Pennsylvania, Virginia, Kentucky, and Indiana, these coal-making conditions began before the close of the Subcarboniferous period. Although their prevalence became general during the deposition, in the eastern half of North America, of the strata of the first and second epochs of the Carboniferous period, especially the first, the strata of the third epoch of the last-named period are usually as destitute of coal as those of the Subcarboniferous period are.

Indeed, the conditions that prevailed during the Upper Coal-Measure

epoch were essentially a repetition of those which prevailed during the Subcarboniferous period. Bearing this in mind, it is easy to understand that those species which are found in both Subcarboniferous and Carboniferous strata may have reached the latter position merely by continuous geographical distribution during the progress of the two periods. Geologists generally divide the strata of the Carboniferous period, in the eastern part of North America, into Upper and Lower Coal-Measures; but, in Iowa and Missouri, they are more or less naturally divided into three formations, as before indicated. Westward from those States, the strata of the Carboniferous period have not been separated into corresponding epochal divisions, and are perhaps not capable of such separation. In the Rocky Mountain region, the strata of this period are widely distributed, and attain a very great thickness compared with that of those in the Mississippi Valley. Those far western Carboniferous strata probably represent in the aggregate the whole Carboniferous period, but in their general lithological and paleontological characters they are all much more nearly like the strata of the Upper Coal-Measures as developed in Iowa, Missouri, and Nebraska than they are like the Middle and Lower Coal-Measures. So far as known to me, no considerable deposit of coal has been found in any strata of the Carboniferous age in the Rocky Mountain region. The accession and cessation of the physical conditions necessarily attendant upon the formation of coal seem to have constituted the principal means of marking, in the accumulating strata, the epochal divisions of the period in Eastern North America. Those conditions of coal-making not having prevailed in the Far West, and, so far as known, the physical changes that occurred there during the period not being coincident with those farther eastward, its epochs were not there marked off in the same manner.

The collections contain a greater number of species from strata of this period than from those of any other; and they were also found more abundant than those of any one of the older periods that have just been noticed.

Of the sixty-two species that have been described or noticed in this report and assigned to this period, one is a Rhizopod; six, Actinozoa; two, Echinodermata; three, Polyzoa; twenty-nine, arthropomatous Brachiopoda;

ten, monomyarian Conchifera; two, dimyarian Conchifera; six, Gasteropoda; and three, Cephalopoda. The two species of Echinodermata do not, however, correctly represent the relative prevalence of that class, because the geologists of the expedition report the presence of scattered joints of Crinoids at almost all the localities, but which, being of little value for classification, were not collected. Of these sixty-two species, thirty-nine are more or less frequently met with in strata of the Carboniferous period in the States bordering upon the Mississippi River.

Although the faunal characteristics of the period are so clearly and fully shown in the collections, the flora of the period, so abundant in the States eastward, has very slight representation among them. Indeed, the collection contains only a single specimen each of *Sigillaria* and *Neuropteris*; the former from White Pine, Nev., and the latter from Cedar Creek, Maricopa County, Ariz.

PERMIAN PERIOD.

The collections contain no fossils that I have definitely referred to the Permian period. A few imperfect specimens were collected from a porous, apparently magnesian, limestone, near Jacob's Pool, Arizona, which is probably at the very summit of the Carboniferous series. One of the species only was satisfactorily recognized, and that is referred to *Bakevellia parva* Meek and Hayden. The collections also contain specimens apparently identical with that species from strata near Camp Wingate, N. Mex. The strata are probably equivalent at the two localities.

MESOZOIC.

TRIASSIC PERIOD.

So far as can be determined, none of the invertebrate fossils contained in the collections are properly referable to the Triassic period.

JURASSIC PERIOD.

The collections contain only eight species in all that I have referred to the Jurassic period. All of these were nowhere found associated together in the same strata; consequently the fauna of the period was nowhere found

fully represented. The collections were made at somewhat widely-separated localities in Nevada and Utah. I have referred the species to the Jurassic period without hesitation in all cases where they were identical, or associated with species hitherto described by Mr. Meek, or Meek and Hayden, and referred by them to that period. With the exception of one crinoidal species, the fauna of the collections is wholly molluscan.

CRETACEOUS PERIOD.

Next to the Carboniferous period, the Cretaceous is represented in the collections by the greatest number of species. These were obtained at various points in New Mexico, Utah, and Colorado. For want of available data, no attempt has been made to refer them respectively to the different subdivisions of the Cretaceous group that have been recognized in Western North America by various geologists; but they are all regarded as clearly referable to the Cretaceous period. Although individuals of most of the species are numerous, it is interesting to observe the restrictions of zoölogical diversity which the collections, consisting of thirty-two species, present. For example, the *Protozoa* and *Radiata* are entirely wanting; the *Articulata* represented by a single species of *Serpula* only; and all the remainder are *Mollusca*. Of these, the *Molluscoidea* are represented by a single species of *Lingula*; thirteen species are monomyarian *Conchifera*; five, dimyarian *Conchifera*; nine, *Gasteropoda*; and four, *Cephalopoda*.

CENOZOIC.

TERTIARY PERIOD.

The collections contain fifteen species from strata at different localities in Utah that I have assigned to the Tertiary period, all of which, except one species of *Cypris*, are either fresh-water or land mollusks, mostly the former. Three species are *Conchifera*, and of the remaining eleven species five are pulmonate Gasteropods, an order that is not represented in any of the other collections.

If I were left to rely upon the zoölogical types alone which the fossils of this small collection present, I should have no hesitation in referring them

all to the Tertiary period. In view of the fact, however, that strata at some localities in that Territory, containing a fauna as suggestive of the Tertiary period as these fossils are, have been found to underlie strata containing true Cretaceous types, I prefer at present to regard the reference of at least the greater part of them to the Tertiary period as provisional.

NOTE.—After writing the foregoing, I learned that my friend, Mr. R. P. Whitfield, the well-known paleontologist, had been making some special studies of the Graptolite slates of Norman's Kill, and wrote to ask his opinion upon the subject, to which inquiry I have received the following reply. I insert it here because of its important bearing upon the question of the age of the shales at Belmont, Nev.:—

“ALBANY, N. Y., February 18, 1875.

“DEAR SIR: Your inquiry in regard to the geological age of the Graptolite slates of Norman's Kill near Albany, N. Y., involves a question of considerable complexity, and is one to which I have given much thought and labor during several years past. The rocks in that vicinity are so altered and disturbed that their relative position is not easily determined from stratigraphical evidence. I have sought diligently at all points for fossil remains, but with only limited success thus far, except as to Graptolites. From the evidence furnished by these fossils, I have reached the conclusion that the Graptolite-bearing layers there are of the age of the *Utica slate*, the following being a summary of the facts I have observed:—

“I have found the following species common to both the Graptolite layers at Norman's Kill and those of the *Utica slate* formation at the mouth of Oxtungo Creek near Fort Plain, N. Y.:—*Graptolithus* (*Monograptus*) *serratulus* Hall; *G. (Diplograptus) pristis* Hall (not Hisinger); *G. (Climacograptus) bicornis* Hall; and *G. (Dicranograptus) ramosus* Hall.

“At Ballston, N. Y., *G. bicornis* Hall is very abundant in the *Utica slate*; and at Barker's Falls, near Sandy Hill, N. Y., *G. pristis* is equally abundant in the same formation. On the island of Orleans in the Saint Lawrence River, and in the valley of the Saint Anne River in Canada, three of the forenamed species are known to occur, viz, *G. pristis*, *G. ramosus*, and *G. bicornis* Hall, in beds known to be of the age of the *Utica slate* (see Geological Report of Canada, 1863, page 200). I think that *G. (Dicranograptus) sextans* Hall also occurs in the same layers with the above-mentioned species, but I will not be positive,

“I am confident that if all these localities were as thoroughly examined as that at Norman's Kill has been, many more species would be found to be common to two or more of them; but the evidence already given is quite sufficient to warrant the conclusion that the slates of the several localities named are of the same geological age, especially when we consider the fact that Graptolites have a very limited geological range. Although only four species are positively known to be common to two or more of the localities named, some of them are found at widely-separated characteristic localities of the *Utica slate*, which shows the great geographical range of the species. None of the Norman's Kill species have been recognized in any other formation than the *Utica slate*, which, while it demonstrates their equivalency of geological age, also shows the limited geological range of this family of fossils.

“Besides the foregoing evidence, the following facts are worthy of consideration in this connection. The lithological features of the Norman's Kill Graptolite beds are peculiar, quite different from the other beds near by, easily recognized at distant localities, and evidently as near like the *Utica slate* as a metamorphic slate can be like an unaltered one. At a locality of these slates near Cohoes, I found specimens of *G. pristis* undistinguishable from Norman's Kill specimens, and in another layer not many feet from the first, but of somewhat different lithological characters, I collected *Orthis testudinaria*, *Leptæna sericea*, *Bellerophon bilobatus*, and *Trinucleus concentricus*, also an *Orthoceras* and several small lamellibranchiate shells. In another layer, a short distance from the first and in a direction opposite the second, but nearly in the strike of the beds, I found specimens of an *Orthis* closely like, if not identical with, *O. subquadrata* Hall. On the opposite side of the Hudson River, near the base of the hills just above and back from Lansingburgh, a mile or more from the river, I obtained *G. pristis* and *G. furcatus*, another Norman's Kill species. Just south of Troy, in the shaly partings between layers of metamorphic limestone, I have found a species of Graptolite in great abundance undistinguishable from *G. amplixicaule* Hall, from the Trenton limestone of Herkimer County, New York. The same species was also found abundantly in the yard of the arsenal at Watervliet by Capt. C. E. Dutton, U. S. A. At Norman's Kill,



only a few hundred yards from the Graptolite beds, in arenaceous layers, I found a species of Graptolite closely resembling and probably identical with one figured in vol. i, *Palæontology of New York*, plate 72, fig. 1 *a*, found at Turiu, Lewis County, N. Y., in the Hudson River group, and at that time identified with *G. pristis*, but probably distinct.

"From the foregoing facts, I infer that the slates below Troy and in the arsenal-yard, together with the associated metamorphic limestones, are the equivalents of the Trenton limestone; and that those at Norman's Kill, which bear the Lewis County species of Graptolites, are probably a continuation of the arenaceous limestones and shales seen in the ravines and railroad cuttings in the town of Knox, Albany County, and of those layers quarried near Schenectady, N. Y., known as the 'bluestone'; and also that they are the equivalents of the Lorraine shales of Central and North Central New York. All the physical peculiarities of the Hudson River beds, as seen at the localities just mentioned, are so exactly repeated in the disturbed and nearly vertical layers within a few hundred yards of the Graptolite beds, that it is difficult to believe they are not geologically identical. One peculiar feature, often noticed on the rocks at Schenectady and elsewhere, is very common at Norman's Kill: it is the appearance as of flowing mud suddenly fixed and hardened on the harder layers; the depressions between the folds and wrinkles being filled with fine mud-shale partings, upon which the layers separate with clean surfaces.

"The beds at Norman's Kill are so much disturbed and contorted that it is impossible to trace a given layer to any considerable distance. There are also many slight faults of a few inches, or sometimes several feet; but I have seen no evidence of any greater one in the vicinity, neither do I think it probable there is one, or that a proper explanation of the condition of the strata makes it necessary to infer that one exists there. The position of the beds there, and the appearance of the Utica slate and of Trenton limestone in the vicinity, can be more reasonably explained by assuming the presence of a series of folds or overlappings, increasing in strength from the vicinity of the nearly horizontal beds of the Hudson River group only a few miles westward from the river, which thus bring up these lower formations, as shown in the accompanying ideal section. You will find this section similar to one given by one of the best and most reliable geologists on page 234, *Geological Report of Canada*, 1863, for these same formations at another locality.

"Very truly, yours,

"R. P. WHITFIELD.

"Dr. C. A. WHITE."

CHAPTER II.

CLASSIFICATION.

If fossils were to be regarded as merely medals or tokens of geological formations, to serve the purpose only of distinguishing the latter from each other, a knowledge of their biological relations among themselves and to existing forms would be unnecessary, and their classification, beyond the application of convenient names, a useless and cumbersome labor. As our knowledge of paleontology increases, however, the great value and importance which the higher groups possess in the solution of geological problems, not to mention their bearing upon purely biological subjects, are more and more recognized. The custom that has been prevalent of recording only the generic and specific names of the fossils described has long been felt by the best paleontologists to be insufficient to give full expression to the significance they possess. Consequently, a more or less complete zoölogical grouping of them has of late become more common. There seems to be no rational ground between a full classification on the one hand and the mere mention of the name of each species in connection with its description on the other. I have, therefore, compiled a full zoölogical classification of the collections that form the basis of this report. In doing so, I have generally adopted the system used by the best specialists in each department; and their use here is merely one of present convenience, and not necessarily an expression of full approval. For example, an obvious reason for the adoption of Dr. Gill's arrangement of the families of *Mollusca* may be found in the fact that the collections by law go to the Smithsonian Institution, where that arrangement has been adopted for its cabinet. This should not be understood as an expression of my own views as to the systematic position of the *Brachiopoda*, any more than the use of Edwards and Haime's classification of corals implies an approval of the assignment of *Chætetes* and related corals to the *Zoantharia*, &c.

Following is a tabular view of the classification I have adopted for the collections, repeated for each of the geological periods they represent.

CLASSIFICATION.

Systematic table of the invertebrate and other fossils.

LOWER SILURIAN AGE.

PRIMORDIAL PERIOD.

PLANTÆ.

CRYPTOGAMIA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Thallogens	Cruziana Linnarssoni White. Cruziana rustica White.
Do	
ANIMALIA.					
MOLLUSCA.					
<i>Molluscoida.</i>					
Brachiopoda	Lyopomata .....	.....	Discinidae	Acrotreta? subidua White. Trematis pannulus White.
Do	do .....	.....	do	
<i>Mollusca vera.</i>					
Gasteropoda	Pteropoda	Thecosomata .....	.....	Hyolithidae	Hyolithes primordialis Hall (?)
ARTICULATA.					
Crustacea	Trilobita .....	.....	Agnostidae	Agnostus interstrictus White.
Do	do .....	.....	Conocoryphidae	Conocoryphe Kingii Meek.
Do	do .....	.....	Asaphidae	Asaphiscus Wheeleri Meek.
Do	do .....	.....	Paradoxidae	Olencillus Gilberti Meek.
Do	do .....	.....	do	Olencillus Howelli Meek.
Do	Vestigia.

CANADIAN PERIOD.

PROTOZOA.

Rhizopoda	Foraminifera .....	.....	.....	Receptaculites ——— (?)
RADIATA.				
Hydrozoa	Hydroida .....	.....	Graptolidae	Phyllograptus Loringi White.
MOLLUSCA.				
<i>Molluscaidea.</i>				
Brachiopoda	Lyopomata .....	.....	Lingulidae	Lingula manticula White.
Do.	do .....	.....	Discinidae	Acrotreta pyxidicula White.
Do.	Arthropomata .....	.....	Strophomenidae	Strophomena fontinalis White.
Do.	do .....	.....	..... do	Orthis Electra Billings (?)
<i>Mollusca vera.</i> *				
Gastropoda	Rhiphidoglossa	Dicranobranchiata	Bellerophonontidae	Bellerophon allegoricus White.
Cephalopoda	Tetrabranchiata .....	.....	Orthoceratidae	Orthoceras colon White.
Do.	do .....	.....	Cyrtoceratidae	Cyrtoceras ——— (?)
ARTICULATA.				
Crustacea	Ostracoda .....	.....	Cypridinidae	Leperditia bivia White.
Do.	Trilobita .....	.....	Asaphidae	Megalaspis belemnurus White.
Do.	do .....	.....	(?)	Dicellocerphalus? flagricaudus White.

Systematic table of the invertebrate and other fossils—Continued.

LOWER SILURIAN AGE—Continued.

TRENTON PERIOD.

RADIATA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Hydrozoa		Hydroida		Graptolitiæ	Graptolithus ramulus White.
Do.		do		do	Graptolithus hypniformis White.
Do.		do		do	Graptolithus pristis Hall (?).
Do.		do		do	Graptolithus quadrimucronatus Hall (?).
Actinozoa		Zoantharia		Favositidæ	Monticulipora Dali Edwards and Haime.
Do.		do		do	Favosites ——— (?).
Do.		do		Thecidæ	Favistella stellata Hall.
Do.		do		Cyathophyllidæ	Zaphrentis ——— (?).
MOLLUSCA.					
Molluscoidæ.					
Brachiopoda		Artthropomata		Strophomenidæ	Strophomena filitexta Hall.
Do.		do		do	Leptæna sericea Sowerby (?).
Do.		do		do	Orthis occidentalis Hall.
Do.		do		do	Orthis plicatella Hall (?).
Do.		do		do	Orthis testudinaria Dalman (?).
Do.		do		do	Orthis biforata Schlot, var. lynx.
Do.		do		Rhynchonellidæ	Rhynchonella argenturica White.
Mollusca vera.					
Conchifera		Heteromyaria		Mytilidæ	Modiolopsis ——— (?).
Gastropoda		Rhipidoglossa		Maclureidæ	Maclurea ——— (?).
Do.	Diaca	do	Podophthalma	Pleurotomariidæ	Raphistoma trochiscus Meek.

CARBONIFEROUS AGE.

SUBCARBONIFEROUS PERIOD.

RADIATA.

Actinozoa .....	.....	Zoantharia .....	.....	Favositidae	Favosites divergens White and Whitfield.
Do. ....	.....	do .....	.....	do	Syringopora Harveyi White.
Echinodermata .....	.....	Blastoidea .....	.....	Pentremiidae	Granatocrinus lotoblastus White.
Do. ....	.....	Crinoidea .....	.....	Platycrinidae	Platycrinus ——— (?)
Do. ....	.....	do .....	.....	Actinocrinidae	Actinocrinus viaticus. White.

MOLLUSCA.

Molluscoida.

Brachiopoda .....	.....	Arthropomata .....	.....	Productidae	Productus parvus Meek and Worthen.
Do. ....	.....	do .....	.....	Strophomenidae	Strophomena rhomboitalis Wilckins.
Do. ....	.....	do .....	.....	Spiriferidae	Spirifer centronatus Winchell.
Do. ....	.....	do .....	.....	do	Spirifer striatus Martin (?)
Do. ....	.....	do .....	.....	do	Spirifer (Syringothyris) extenuatus Hall.
Do. ....	.....	do .....	.....	do	Spirifer (Martina) peculiaris Shumard.
Do. ....	.....	do .....	.....	do	Spirigera monticola White.
Do. ....	.....	do .....	.....	do	Spirigera obmaxima McChesney.
Do. ....	.....	do .....	.....	Terebratulidae	Terebratula (Dielasma) Burlingtonensis White.

Mollusca vera.

Conchifera .....	.....	Dimyaria .....	.....	Cardiidae ?	Conocardium ——— (?)
Gastropoda .....	.....	Rhipidoglossa .....	.....	Euomphalidae	Euomphalus luxus White.

CARBONIFEROUS PERIOD.

PROTOZOA.

Rhizopoda	Foraminifera	Fusulina cylindrica Fischer.
-----------------	-------	--------------------	-------	-------	------------------------------

Systematic table of the invertebrate and other fossils—Continued.

CARBONIFEROUS AGE—Continued.

CARBONIFEROUS PERIOD—Continued.

RADIATA.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Actinozoa		Zoantharia		Favositidae	Chetetes milleporaceus Edwards and Haime.
Do.		do		do	Rhombipora lepidodendroides Meek.
Do.		do		do	Syringopora multattenuata McChesney.
Do.		do		Cyathophyllidae	Syngrenis excentrica Meek.
Do.		do		do	Lophophyllum proliferum (var.) McChesney.
Do.		do		do	Lithostrotion Whitneyi Meek.
Echinodermata		Echinoidea		Archaeocidaridae	Archaeocidaris ornatus Newberry.
Do.		do		do	Archaeocidaris tridifer White.
MOLLUSCA.					
Molluscoida.					
Polyzoa		Gymnolemata		Myriaporidae	Glauconome nereidis White.
Do.		do		do	Synocladia biserialis Swallow.
Do.		do		do	Polypora stragula White.
Brachiopoda		Arthropomata		Productidae	Productus costatus Sowerby.
Do.		do		do	Productus Prattianus Norwood.
Do.		do		do	Productus punctatus Martin.
Do.		do		do	Productus Nebrascensis Owen.
Do.		do		do	Productus longispinus Sowerby.
Do.		do		do	Productus muricatus Norwood and Pratten.
Do.		do		do	Productus semireticulatus Martin.
Do.		do		do	Productus Mexicanus Shumard.
Do.		do		do	Chonetes granulifera Owen.
Do.		do		do	Chonetes mesoloba Norwood and Pratten.

Do.....	do.....	do.....	do.....	do.....	Chonetes platynota White.
Do.....	do.....	do.....	do.....	Strophomenidæ	Orthis Pecosii Marcou.
Do.....	do.....	do.....	do.....	do.....	Hemipronites crinitaria Phillips.
Do.....	do.....	do.....	do.....	do.....	Meekella striatocostata Cox.
Do.....	do.....	do.....	do.....	Rhynchonellidæ	Rhynchonella Uta Marcou.
Do.....	do.....	do.....	do.....	do.....	Rhynchonella Rockymontana Marcou.
Do.....	do.....	do.....	do.....	do.....	Rhynchonella Wasatchensis White.
Do.....	do.....	do.....	do.....	do.....	Rhynchonella metallica White.
Do.....	do.....	do.....	do.....	Spiriferidæ	Spirifer cameratus Morton.
Do.....	do.....	do.....	do.....	do.....	Spirifer Rockymontanus Marcou.
Do.....	do.....	do.....	do.....	do.....	Spirifer striatus Martin (?).
Do.....	do.....	do.....	do.....	do.....	Spirifer (Martinia) planoconvexus Shumard.
Do.....	do.....	do.....	do.....	do.....	Spirifer (Martinia) glaber var. contracta Meek and Worthen.
Do.....	do.....	do.....	do.....	do.....	Spiriferina Kentuckensis Shumard.
Do.....	do.....	do.....	do.....	do.....	Spiriferina octoplicata Sowerby.
Do.....	do.....	do.....	do.....	do.....	Retzia Mormonii Marcou.
Do.....	do.....	do.....	do.....	do.....	Spirigera subtilita Hall.
Do.....	do.....	do.....	do.....	do.....	Spirigera planosulcata Phillips.
Do.....	do.....	do.....	do.....	Terebratulidæ	Terebratula (Dielasma) bovidens Morton.
<i>Mollusca vera.</i>					
Conchifera .....	.....	Monomyaria .....	.....	Pectinidæ	Aviculopecten occidentalis Shumard.
Do.....	do.....	do.....	do.....	do.....	Aviculopecten Coreyanus White.
Do.....	do.....	do.....	do.....	do.....	Aviculopecten interlineatus Meek and Worthen.
Do.....	do.....	do.....	do.....	do.....	Aviculopecten McCoyi Meek and Hayden.
Do.....	do.....	do.....	do.....	Pinnidæ	Pinna peracuta Shumard (?).
Do.....	do.....	do.....	do.....	Pteridæ	Monopteria Marian White.
Do.....	do.....	do.....	do.....	do.....	Myalina recurvirostris Meek and Worthen (?).
Do.....	do.....	do.....	do.....	do.....	Myalina? Swallovi McChesney.
Do.....	do.....	do.....	do.....	do.....	Bakevella parva Meek and Hayden.
Do.....	do.....	Dimyaria	do.....	Trigonidæ	Schizodus Wheeleri Swallow.
Do.....	do.....	do.....	do.....	Anatinidæ	Allorisma subuneata (var.) Meek and Hayden.
Gastropoda	Prosopcephala	Solenoncha .....	.....	Dentalidæ	Dentalium canna White.
Do.....	Dicæa	Rhipidoglossa	Dicranobranchia	Bellerophonitidæ	Bellerophon crassus Meek and Worthen.
Do.....	do.....	do.....	Podophthalma	Euomphalidæ	Euomphalus pernodosus Meek and Worthen.
Do.....	do.....	Pectinibranchiata	Tentoglossa	Naticidæ	Naticopsis nana Meek and Worthen.

Systematic table of the invertebrate and other fossils—Continued.

CARBONIFEROUS AGE—Continued.

CARBONIFEROUS PERIOD—Continued.

Mollusca vera—Continued.

Class.	Subclass.	Order.	Suborder.	Family.	Genera and species.
Gasteropoda....	Dioeca.....	Pectinibranchiata..	Teniolglossa.....	Capulidæ	Platyceras Nebraska Meek.
Do.....	do	do	do	Macrocheilidæ	Macrocheilus anguliferus White.
Cephalopoda ..	.....	Tetrabranchiata....	.....	Goniatiidæ	Goniatites ——— (?).
Do.....	.....	do .....	.....	Nautilidæ	Nautilus latus Meek and Worthen (?).
Do .....	.....	do .....	.....	do	Nautilus Springeri White and St. John (?).
MESOZOIC AGE.					
JURASSIC PERIOD.					
RADIATA.					
Echinodermata ..	.....	Crinoidea .....	.....	Pentacrinidæ	Pentacrinus asteriscus Meek and Hayden.
MOLLUSCA.					
<i>Mollusca vera.</i>					
Conchifera .....	.....	Monomyaria .....	.....	Ostreidæ	Ostrea strigilecula White.
Do.....	.....	do .....	.....	Pectinidæ	Camptonectes stygius White.
Do.....	.....	do .....	.....	do	Camptonectes bellistriatus Meek and Hayden.
Do.....	.....	do .....	.....	Pteridæ	Inoceramus crassalatus.
Do.....	.....	Dimyaria .....	.....	Trigonidæ	Myophoria ambilineata.
Do.....	.....	do .....	.....	do	Trigonia ——— (?).
Gasteropoda.....	Dioeca	Rhiphidoglossa ...	Podophthalma	Neritidæ	Neritina (?) phaseolaris White.

CRETACEOUS PERIOD.

MOLLUSCA.

Molluscoida.

Brachiopoda.....	.....	Lyopomata.....	.....	Lingulidæ.....	Lingula subspatula Hall and Meek.
<i>Mollusca vera.</i>					
Conchifera.....	.....	Monomyaria.....	.....	Ostreidæ.....	Ostrea cortex Conrad.
Do.....	.....	do.....	.....	do.....	Ostrea prudentia White.
Do.....	.....	do.....	.....	do.....	Gryphea Pichei Morton.
Do.....	.....	do.....	.....	do.....	Exogyra ponderosa Roemer.
Do.....	.....	do.....	.....	do.....	Exogyra leviuscula Roemer.
Do.....	.....	do.....	.....	do.....	Exogyra costata Say, var. fluminis White.
Do.....	.....	do.....	.....	Pectinidæ.....	Camptonectes platessa White.
Do.....	.....	do.....	.....	Limidæ.....	Lima Wacoensis Roemer.
Do.....	.....	do.....	.....	Pteriidæ.....	Inoceramus problematicus Schlot.
Do.....	.....	do.....	.....	do.....	Inoceramus deformis Meek.
Do.....	.....	do.....	.....	do.....	Inoceramus fragilis Hall and Meek.
Do.....	.....	do.....	.....	do.....	Inoceramus Barabini Morton.
Do.....	.....	do.....	.....	do.....	Inoceramus dimidiatus White.
Do.....	.....	do.....	.....	do.....	Inoceramus flaccidus White.
Do.....	.....	do.....	.....	Pinnidæ.....	Pinna petrina White.
Do.....	.....	Dimyaria.....	.....	Arcidæ.....	Idonearca depressa White.
Do.....	.....	do.....	.....	Lucinidæ.....	Lucina subundata Hall and Meek.
Do.....	.....	do.....	.....	Glossidæ.....	Veniella goniophora Meek.
Do.....	.....	do.....	.....	Maclridæ.....	Maclra? incompta White.
Do.....	.....	do.....	.....	Anatinidæ.....	Leiopistha (Psilomya) Meekii White.
Do.....	.....	do.....	.....	do.....	Leiopistha (Cymella) undata Meek and Hayden.
Do.....	.....	do.....	.....	Corbulidæ.....	Corbula nematophora Meek.
Gasteropoda.....	.....	Rhipidoglossa.....	.....	Neritidæ.....	Neritina (Velatella) carditoides, Meek.
Do.....	.....	Pectinibranchiata.....	.....	Aporrhaidæ.....	Anchura? fusiformis Meek.
Do.....	.....	do.....	.....	do.....	Lispedesthes nuptialis White.
Do.....	.....	do.....	.....	do.....	Lispedesthes lingulifera White.

Sytematic table of the invertebrate and other fossils—Continued.

MESOZOIC AGE—Continued.

CRETACEOUS PERIOD—Continued.

Mollusca vera—Continued.

Class.	Subclass.	Order	Suborder.	Family.	Genera and species.
Gastropoda....	Diuca	Pectinibranchiata..	Tanioglossa.....	Tecturidae.....	Anisomyon borealis Morton.
Do.....	do	do	do	do	Anisomyon centrale Meek.
Do.....	do	do	do	Turritellidae	Turritella uvasana Conrad.
Do.....	do	do	do	do	Cassiope Whitfieldi White.
Do.....	do	do	do	do	Eulimella? funicula Meek.
Do.....	do	do	do	Pyramidellidae	Turbonilla (Chemnitzia) melanopsis Conrad.
Do.....	do	do	do	Admetidae	Admetopsis gregaria Meek.
Cephalopoda ..	do	Tetralbranchiata..	Toxoglossa	Baculitidae	Baculites ovatus Say.
Do.....	do	do	do	do	Baculites ovatus var.
Do.....	do	do	do	Schaphitidae	Schaphites Warreni Meek and Hayden.
Do.....	do	do	do	Ammonitidae	Buchiceras Swallowi Shumard.
Do.....	do	do	do	do	Ammonites Leevianus White.
Do.....	do	do	do	do	Ammonites placenta DeKay.
Do.....	do	do	do	Turritidae	Helicoceras Pariense White.

ARTICULATA.

Vermes	Tubicola	Serpulidae	Serpula intricata White.
--------------	----------------	------------------	--------------------------

CENOZOIC AGE.

TERTIARY PERIOD.

MOLLUSCA.

Mollusca vera.

Conchifera	Dimyaria	Unionidae	Unio vetustus Meek.
Do.....	do	Cyrenidae	Cyrena (Veloritina) Durkeei Meek.

Do.	do	do	do	do	Sphærium ——— (?).
Gasteropoda	Pulmonifera	Pulmonata	Basommatophora ..	Linneidae	Planorbis Utahensis Meek.
Do.	do	do	do	do	Planorbis ——— (?).
Do.	do	do	do	Physidae	Physa Bridgerensis Meek.
Do.	do	do	do	do	Physa pleromatis White.
Do.	do	do	Geophila	Helicidae	Helix Leidy Hall and Meek.
Do.	Dioeca	Pectinibranchiata ..	Teniglossa	Melaniidae	Goniobasis tenuicarinata Meek and Hayden.
Do.	do	do	do	do	Goniobasis Nebrascensis Meek and Hayden.
Do.	do	do	do	do	Goniobasis tenera Hall.
Do.	do	do	do	Viviparidae	Viviparus trochiformis Meek and Hayden.
Do.	do	do	do	do	Viviparus Ionicus White.
Do.	do	do	do	do	Viviparus? ——— (?).
ARTICULATA.					
Crustacea	do	Ostracoda	do	Cypridinidae	Cypris ——— (?).

CHAPTER III.

LOWER SILURIAN AGE.

PRIMORDIAL PERIOD.

PLANTÆ.

CRYPTOGAMIA.
CLASS THALLOGENES.

GENUS CRUZIANA D'Orbigny, 1842.

Cruziana Linnarssoni White.Plate I, fig. 2 *a*, *b*, and *c*.*Cruziana Linnarssoni* White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 5.

Body not much flattened, oblong or subelliptical in outline, but narrowed and more or less pointed at the ends, one of which is a little more acutely pointed than the other; median furrow traversing the whole length of the body, the greater part of it being deep and distinct, but a part of it is usually more shallow.

Surface marked by few or no transverse rugæ, but upon the more pointed end of some of the specimens there is a secondary furrow upon each side of the median furrow; these converge to the point where they join the median furrow, but they disappear in the opposite direction before reaching the middle of the body. Upon others, an incipient furrow is sometimes seen at each side of the half of the body that is more acutely pointed. These are near to, and their direction is parallel with, the sides of the body. This character is shown in figure 2 *a* and *b*, Plate I. Stipe rather small, attached about midlength of the body in the bottom of the median furrow, but it is, however, rarely preserved.

Length of body from two and a half to seven and a half centimeters.

It is not improbable that the form represented by figure 2 *b* and *c* is specifically distinct from the form represented by figure 2 *a*, especially as the first-named form is quite a constant one among the specimens of the collections. I have, however, not felt fully warranted by the collections yet made in separating them under a different specific name, but I have selected the form represented by figure 2 *a* as typical of the species here described.

Compared with *C. dispar* Linnarsson, from the Primordial rocks of Vestergotland, it differs in being more pointed at the extremities and otherwise of different outline, and also in having few or none of the transverse rugæ that so distinctly mark that species. From *C. grenvillensis* Billings (Palæozoic Fossils of Canada, vol. i, page 101), it differs in outline, in having few or no transverse rugæ or wrinkles, and in having a median furrow traversing its whole length instead of occupying only a part of its length as the furrow does in that species.

It is thought possible that the specimens of this species in the collection may have been denuded of rugæ before they became imbedded, because the surface of some of the slabs upon which they are found are strewn with small bodies that resemble detached rugæ. On the other hand, such a supposition seems untenable, because some of those slabs are found to contain both *C. Linnarssoni* and the following described species; the former being nude as usual, and the latter having their abundant rugæ in place.

The specific name is given in honor of Prof. J. G. O. Linnarsson, the able Swedish geologist.

Position and locality.—Tonto shale, probably of the Primordial period, Grand Cañon of the Colorado River, Mohave County, Arizona.

***Cruziana rustica* White.**

Plate I, fig. 1 *a* and *b*.

Cruziana rustica White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 5.

Body more or less elongated, flattened, more or less distinctly bilobed, the lobes being depressed-convex and the ends blunt; median furrow extending the whole length of the body and comparatively shallow through-

out; transverse rugæ numerous, some of them interrupted, but others extending from the outer borders to the middle of the median furrow, arching slightly as they cross the lobes.

Length of the body in proportion with the width variable; in some specimens (perhaps broken ones) the length and width being about equal, while in others the length is two or three times as great as the width. The width varies in different specimens from three and a half to more than four centimeters. It is not improbable that this species reached a much greater length than is indicated by any of the specimens in the collection, and that even the longest of these are only fragments. No indications of a stipe arising from the median furrow, such as is seen in *C. Linnarrsoni* and other species, have been observed.

This species is larger than *C. Linnarrsoni*, with which it is associated; of very different aspect and of different and more variable proportions. It somewhat resembles *C. bilobata* (*Fucoides bilobatus* Vanuxem, Geology of the Third District of New York, page 79) of the Clinton group; but the proportions of the body and of the lobes, respectively, are different.

Position and locality.—Tonto shale, probably of the Primordial period. Grand Cañon of the Colorado River, Mohave County, Arizona.

ANIMALIA.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER LYOPOMATA.

FAMILY DISCINIDÆ.

GENUS ACROTRETA Kutorga, 1848.

Acrotreta? subsidua White.

Plate I, fig. 3 *a*, *b*, *c*, and *d*.

Acrotreta? subsidua White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 6.

Shell thin, corneous, discoid, subcircular or somewhat suboval in outline, the transverse diameter being a trifle greater than the longitudinal;

sides regularly, and front broadly, rounded; posterior margin slightly straightened, forming a comparatively short, slightly convex, or nearly straight hinge-line.

Dorsal valve flattened; beak marginal or nearly so, not prominent; interior surface having a slightly-elevated median ridge, beginning beneath the beak and extending to about the middle of the valve, where it disappears.

The condition of all the specimens of this species which the collections contain is such that the muscular impressions are not distinctly shown, but those of the posterior adductors appear to be small, and placed nearly beneath the beak, one on each side of the median ridge just mentioned; between these muscular impressions and the posterior margin there is, at each side, an obscure diverging ridge, or fold, which seems to blend with the postero-lateral margin.

Ventral valve moderately convex in the umbonal region, but more flattened anteriorly and laterally; beak excentric, somewhat prominent, and minutely perforate. Some of the specimens show what appear to be small adductor impressions placed in the apex, close to the foramen, one at each side of it. One specimen shows a slight flattening of the space upon the outer surface, between the apex and the hinge, producing the appearance there of an indistinctly-defined cardinal area.

The inner surface of both valves of all the specimens of this species contained in the collections has been more or less exfoliated by weathering, whereby some of the principal characters have been obscured. Consequently, the foregoing description is not only incomplete, but it is probable that the discovery of more perfect specimens may show necessity for modifying it. The cast of a single valve found associated with those used in this description, showing large and distinct muscular impressions, already suggests such a modification; but its characters are not embodied in the description, because that specimen is not certainly known to belong to the species. The specimen referred to is illustrated by figure 3 *d*, Plate I. The other specimens all show fine radiating lines in the structure of the shell, and also concentric laminae of growth. They are all compressed in dark shale, and show only the interior surfaces of the valves, none showing

the external surface. The latter is supposed to be lamellose or otherwise so roughened as to have caused it to adhere to the shale, while the smooth interior surface has readily separated in the plane of fission.

This shell is not only specifically different from any other known to me; but in its want of a well-defined area and in its discoid, instead of pyramidal, form, it differs perhaps generically from those *Discinidæ* that are usually referred to the genus *Acrotreta*. I have referred it to that genus provisionally, because the combination of its characters renders its reference to any other established genus known to me equally inconsistent, and because the specimens are not complete enough to base a new generic description upon which the species may or may not possess.

Length of the largest specimen in the collection, six millimeters; width of the same, seven millimeters.

Position and locality.—Strata of the Primordial period, probably of the epoch of the Potsdam sandstone, Antelope Spring, House range, Utah.

GENUS TREMATIS Sharpe, 1847.

Trematis pannulus White.

Plate I, fig. 4 *a* and *b*.

Trematis pannulus White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 6.

Associated with *Olenellus Gilberti* Meek, a single imperfect specimen of *Trematis* has been discovered, which, although consisting only of a single valve, possesses such characteristic surface-markings as to indicate its specific separation from all other known forms of the genus.

The diameter of the specimen is about three millimeters; outline apparently subcircular or a little broader than long; apex moderately prominent and situated near the posterior margin. Surface marked by a very fine net-work of oblique raised lines, dividing it up into minute, four-sided, pore-like pits, which cause it to resemble, under the lens, the texture of finely-woven cloth.

In the character of its surface-markings, this species is nearly related to *T. punctata* Sowerby, sp., as figured by Davidson in his Monograph of British Fossil Brachiopoda, part vii, No. 1. That species, however, reaches

a much larger size than our shell, and the small pits that similarly mark its surface are six-sided, instead of four-sided as in ours. The surface of *T. siluriana* Davidson, another allied species, has the pits arranged in radiating instead of oblique lines.

Position and locality.—Shales of the Primordial period and probably of the Potsdam epoch, Pioche, Nevada.

MOLLUSCA VERA.

CLASS GASTEROPODA.

SUBCLASS PTEROPODA.

ORDER THECOSOMATA.

FAMILY HYOLITHIDÆ.

GENUS HYOLITHES Eichwald, 1840.

Hyolithes primordialis Hall (?).

Plate I, fig. 5 *a*, *b*, *c*, *d*, and *e*.

Theca primordialis Hall, 1861, Geol. Surv. Wisconsin (pamph.), 48.

Theca primordialis Hall, 1862, Geol. Surv. Wisconsin, i, 21.

Theca primordialis Hall, 1863, Sixteenth Ann. Reg. Rep. N. Y. State Cab., 135.

Hyolithes primordialis Hall and Whitfield, 1873, Twenty-third Ann. Reg. Rep. N. Y. State Cab., 242.

Hyolithes primordialis?, White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 6.

Shell slender, acutely pointed; test rather thin; transverse section subsemicircular or subtrihedral; edges or longitudinal angles nearly or quite straight, meeting at an apical angle, varying in different specimens from fifteen to twenty degrees; dorsal side slightly convex or nearly flat along the middle; ventral side forming a nearly semicircular arch in transverse section, but it sometimes shows an obtuse, rounded angle, extending from apex to aperture along the median line; the lateral angles, formed by the junction of the dorsal and ventral sides, sharply rounded; margin of the aperture at the flattened side extended and broadly rounded; that of the convex side nearly transverse, but sometimes showing a slight emargination at the middle. Upon the flattened or dorsal side of the solid stony core of one of the specimens, from which the test is removed, there appears a very slightly raised longitudinal ridge, the width of which at all parts of its length is

about one-quarter that of the whole width of the shell. This, of course, indicates the existence of a shallow, tapering, longitudinal groove upon the inner surface of the shell; but, so far as observed, there is no external indication of its presence. Surface marked by lines and undulations of growth, which are apparently strongest upon the flattened side.

Length, from fifteen to eighteen millimeters.

In the case of simple forms like these, it often seems necessary to take into careful consideration differences that, in more complex forms, would be considered as merely individual, or slightly varietal modifications, and therefore disregarded. The difference between our specimens and those of Professor Hall, as represented by his figures and description, seems to be of this slight character; and it is only in view of the fact just stated that doubt is felt as to the specific identity of our shell with *H. primordialis*. The principal external differences (the internal characters of Professor Hall's shell have not been made known) are that our forms are a little more robust, a little less flattened upon the dorsal side, and the convexity of the lines of growth and of the margin of the aperture at that side are a little greater. From *H. gregaria* Meek and Hayden, it differs in its greater size, its concentrically-marked surface, and in the outline of its aperture.

Position and locality.—Strata of the Primordial period, and probably of the Potsdam epoch, Pioche, Nevada.

ARTICULATA. CLASS CRUSTACEA.

ORDER TRILOBITA.

FAMILY AGNOSTIDÆ.

GENUS AGNOSTUS Brongniart, 1821.

Agnostus interstrictus White.

Plate II, fig. 5 *a* and *b*.

Agnostus interstrictus White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 7.

Head and pygidium of almost exactly equal size and general shape and otherwise closely resembling each other.

Head a trifle broader than long, regularly rounded in front; sides at the postero-lateral regions subparallel; postero-lateral angles truncated; the whole exterior margin, including the truncated portions just named, provided with a narrow, raised rim, the elevation of which forms a linear depression, or groove, between it and those portions of the head which it incloses; space between this marginal depression and the glabella a little wider posteriorly than it is in front, convex throughout, and its surface apparently smooth. Glabella conical, widest posteriorly, moderately convex, sides nearly straight, well defined by the dorsal furrows, abruptly rounded in front; a minute tubercle situated on the median line near the posterior end, and a shallow groove or furrow extending across near the front end, defining a frontal lobe of moderate size.

Thorax narrower than the head and pygidium, giving the body the appearance of being constricted at the middle; axial lobe broad, consisting of two segments, both of which are tumid at the ends adjoining the dorsal furrows; lateral lobes very narrow; pleuræ almost as wide as long; each pleura tumid, and rounded at its exterior end.

Pygidium having an outline like that of the head, and is also provided with a similar elevated marginal rim and linear depression within it; axial lobe a little longer than the glabella, and consequently that lobe reaches a little nearer the posterior margin of the pygidium than the glabella does to the anterior margin of the head, moderately convex in elevation and also in each lateral outline; a minute tubercle is situated on the median line near the anterior end, corresponding in size and relative position with the one on the glabella before mentioned; space between the dorsal furrows and the margin convex, its surface apparently smooth; upon the outer edge of the border of the pygidium, at each side and a little nearer to the axial extremity than to the antero-lateral angles, there is a minute protuberance, suggestive of an incipient spine. Besides the slight differences between the head and pygidium, already referred to, the pygidium differs also in having a faint appearance of segmentation of its axis and in a slight folding-backward of the marginal rim at the antero-lateral angles.

Length of body, eight millimeters; width of head and also of the pygidium, five millimeters; width of thorax, four millimeters.

This beautiful *Agnostus* is quite unlike any described American species, and is more nearly related to *A. integer* Beyrich, from the Primordial strata of Europe, than any other known to me. Compared with that species, it is found to reach a larger size; its glabella is narrowed in front instead of having its sides nearly parallel; the axial lobe of the pygidium is narrower behind than in front, instead of being of nearly the same width at each end, and has the sides of that lobe convex instead of nearly straight, as they are in *A. integer*.

Position and locality.—Shales of the Primordial period, probably of the Potsdam epoch, Antelope Spring, House range, Utah, where it is associated with *Conocoryphe Kingii* Meek, and other fossils of Primordial type, and where three entire specimens have been obtained, besides a number of fragments.

FAMILY CONOCORYPHIDÆ.

GENUS CONOCORYPHE Corda, 1847.

SUBGENUS PTYCHOPARIA Corda, 1847.

Conocoryphe (*Ptychoparia*) *Kingii* Meek.

Plate II, fig. 2 *a*, *b*, and *c*.

Conocoryphe (*Conocephalites*) *Kingii* Meek, 1870, Proc. Acad. Nat. Sci. Phila., 63.

Conocoryphe (*Ptychoparia*) *Kingii* Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, & Utah, 487.

Outline of body ovate; the width compared with the length being about as two to three. Head semicircular, or nearly so; the exterior margin regularly rounded, and bordered by a narrow marginal rim, which is nearly of uniform width throughout, but is sometimes a little stronger in front of the glabella than elsewhere; posterior margin very slightly concave in adult specimens, but a little more concave in young ones; near the postero-lateral angle of the head, this margin bends abruptly backward, terminating in cheek-spines of moderate length; these spines in the adult extend backward to a point about opposite the second segment of the thorax, but in the young the spines are proportionally longer, and the whole head larger compared with the remainder of the body. Glabella slightly elevated above the cheeks, clearly defined by the shallow dorsal furrows; its anterior end reaching a point about one-half its own length from the front margin of the

head; width at the base, compared with its full length, about as seven to eight; sides straight or nearly so; anterior end abruptly and posterior end very broadly rounded; occipital furrow well defined, and continuous with a similar but rather broader furrow at each side, that extends across the cheek parallel with and near the posterior margin of the head, giving that margin a raised border; lateral furrows absent or very indistinct in adult specimens, but in well-preserved young ones there are indications of four pairs of lobes. Facial sutures curving outward and forward from the anterior ends of the eyes, or from a point a little forward of their anterior ends, reaching the marginal groove within the raised border of the head at points a little wider apart than the eyes are at their anterior ends, then, bending somewhat abruptly inward, they cut the anterior margin; posteriorly, the sutures extend almost directly outward from the posterior ends of the eyes, then, by broad backward curves, which become more abrupt as they proceed, they cut the posterior margin of the head not far from its postero-lateral angles and just inside the bases of the cheek-spines.

Eyes rather small, slightly arching outward, placed well back toward the posterior margin of the head; visual surfaces narrow, our specimens showing no reticulations; other portions of the head apparently without surface-markings or ornamentation, except that some specimens show a very faint ridge extending transversely from the anterior end of each eye toward the anterior portion of the glabella, but ending at the dorsal furrows before reaching it.

Thorax longer than the head, measuring seventeen millimeters in a specimen having a head thirteen millimeters long, the same thorax measuring twenty-five millimeters wide at its widest part; axial lobe depressed, narrow; sides straight, about two-thirds as wide as one of the lateral lobes at the anterior end of the thorax, about one-third wider at its anterior than it is at its posterior end; segments thirteen in number, passing nearly or quite straight across the lobe; a slight transverse prominence usually seen at each end of every axial segment near the bottom of the dorsal furrows, producing the appearance there of a corrugated, raised line along the whole length of each furrow; lateral lobes slightly convex, a little widest about midlength; pleuræ nearly transverse with the axis of the body, nearly

straight, but arching a little backward at their outer ends; extremities abruptly pointed, the points directed obliquely backward, and also bent a little horizontally outward, so as to produce the appearance of a slightly-flattened, serrated border along each side of the thorax, each pleura having a well-defined groove, which is widest and deepest about the middle, and extends from the inner end to near the outer extremity, where it becomes obsolete and ends at the flattened tip.

Pygidium subsemicircular, comparatively small, only a little more than one-third as long as the thorax, regularly rounded behind, where it has a narrow, flattened border of nearly uniform width all around; axial lobe ending at the marginal border; segments indistinct, but five or six in number are recognizable in some specimens; lateral lobes much depressed, twice the width of the axial lobe at the anterior end of the pygidium; segments indistinct, but may be distinguished by their grooves, which are deeper than those that mark the limits of each; grooves curving backward, and, like those of the pleuræ, becoming obsolete upon reaching the flattened marginal border.

The whole surface is apparently smooth, except that there are some faint indications of radiating striæ upon the exterior portions of the head of well-preserved specimens, discernible only by means of a lens.

Length of the largest specimen in the collections, five centimeters; breadth of the same across the thorax, thirty-three millimeters.

Although this species resembles an *Olenus* in general outline and aspect, the possession of blunt and shortened, instead of extended and pointed, pleuræ, the presence of faint elevated lines between the eyes and glabella, the radiating lines upon the surface of the head, together with the other characters above described and shown in the figures, leave no doubt as to the propriety of referring it to the genus *Conocoryphe*. The presence of only thirteen thoracic segments instead of fourteen (the number attributed to the genus by Corda) is not regarded as of generic importance in this case.

A number of entire and more or less perfect specimens of this fine *Trilobite* are contained in the collections, but they have all been a little flattened by compression. The finer details of structure of most of them have

also been obscured by contact with a peculiar accumulation of calcite or arragonite in the form of a layer from two to four millimeters in thickness beneath the whole crust; the crystalline prisms being vertical to the plane of the fossil and also to that of the layer of shale in which it was imbedded.

Position and locality.—Shales of the Primordial period, probably of the Potsdam epoch, Antelope Spring, House range, Utah.

FAMILY ASAPHIDÆ.

GENUS ASAPHISCUS Meek, 1872.

Asaphiscus Wheeleri Meek.

Plate II, fig. 1 *a, b, c, d, e, and f.*

Bathypurellus (Asaphiscus) Wheeleri Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, & Utah, 485.

Body oblong-ovate in outline; surface smooth. Head depressed-convex; front margin regularly rounded; postero-lateral angles abruptly rounded, without cheek-spines; exterior margin bent shortly upward all around, producing a raised border of considerable width, and also a rather deep linear depression, or groove, parallel with that border and between it and the remainder of the cheeks. Glabella conical, much wider behind than in front, depressed; space between its anterior end and the marginal groove about equal to the width of the raised marginal rim in front of it; outline well defined by the narrow dorsal furrows; sides nearly straight; anterior end abruptly and posterior end broadly rounded, without lateral furrows, or at least they are hardly discernible; occipital furrow shallow, broad, but somewhat distinct and uniform, extending entirely across the glabella, and continuous with furrows similar to itself that extend to the postero-lateral angles of the head; the latter furrows lie parallel with and near to the posterior margin of the head, giving that margin also a raised border, somewhat like the one upon the exterior margin. Eyes comparatively small, crescentic, situated nearly opposite the mid length of the glabella, and nearly equidistant from it and the posterior margin.

Thorax having nine segments; its length not quite so great as that of the head; axis broadest anteriorly, more strongly convex, and about one-third narrower than the lateral lobes are; segments extending straight across the lobe; lateral lobes depressed, their greatest convexity along the middle;

pleuræ bluntly pointed at their outer ends, the points not being directed very strongly backward; their inner ends so joined to the axial segments that they have the appearance of lapping a little upon them just inside the dorsal furrow; grooved, the groove being deepest about midlength, where the outer and inner portions of its front border meet at a distinct but very obtuse angle; grooves extending from the dorsal furrow nearly to the extremity of the pleuræ, where they disappear.

Pygidium somewhat semicircular in outline, distinctly trilobate; segmentation indistinct, so much so in some of the specimens that the surface appears nearly as plain as that of an *Asaphus*, but the segmentation is usually more distinctly shown upon surfaces from which the crust has been removed; axis prominent, especially at its distal end, where it terminates abruptly at the inner edge of the broad marginal border; segments of axial lobe eight or ten; lateral lobes much depressed, a little wider than the axial lobe at the anterior end, and narrowing to an incurved point at the end of the axis; the whole exterior margin having a broad, flat border of nearly uniform width throughout; the under surface of this border marked by fine, somewhat irregular, longitudinal striæ, such as are usually seen upon corresponding parts of *Asaphus*.

The largest specimen in the collections is about seven centimeters long.

These specimens are the same that were used by Mr. Meek in his description of this species, and upon which he also based his genus *Asaphiscus*.

Position and locality.—Strata of the Primordial period, probably of the Potsdam epoch, near Antelope Spring, House range, Utah.

FAMILY PARADOXIDÆ.

GENUS OLENELLUS Hall, 1861.

Olenellus Gilberti Meek.

Plate II, fig. 3 *a*, *b*, *c*, *d*, and *e*.

Olenellus Gilberti Meek, 1874 (manuscript).

Olenellus Gilberti White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 7.

Head subsemicircular or semi-oval, the length being to the breadth at the posterior border about as four or five to seven; both the external and

posterior margins bordered by a narrow, continuous, slightly-raised rim, that of the external margin being* placed a little within its edge, that of the posterior margin continuous across the occipital lobe of the glabella; the postero-lateral angles produced into slender spines, which are terete, very slightly incurved, not much widened at their bases, and in our specimens are about equal in length to one-fourth of the transverse diameter of the head at its base. The posterior margin of the head, near each postero-lateral angle, bends abruptly forward a little, forming a kind of notch or small retreating angle with the backward-projecting spine, and also giving the outer corner of the movable cheek the appearance of being rounded. Eyes narrow, broadly arching outward, narrowness and convexity of curve both increasing posteriorly; their outer margins nearly equidistant from the center and the outer margins of the head, which distance is also about equal to the length of the eye. Glabella distinctly lobed, the furrows extending nearly or quite to its center; frontal lobe much larger than the others, subcircular in outline, prominent, tumid, regularly rounded in front, and a little wider than the remainder of the glabella; anterior, middle, posterior, and occipital lobes of nearly uniform size.

The remainder of the body is unknown, with the exception of single specimens each of the long third pleura of the right side, and one of the others, probably belonging behind the third segment. The long one is broadly and somewhat deeply grooved upon the surface of its inner portion, where the anterior edge of the groove is elevated, the groove becoming shallower and narrower upon the outer portion, and finally disappearing toward the point of the pleura; outer portion of the pleura bending strongly but not very abruptly backward, and ending in a strong, flattened, spine-like point. The other pleura mentioned is grooved like the long one, but the anterior edge of its inner portion is not turned upward, as it is in the other.

The specimens of the collection are all imperfect, consisting only of flattened impressions in shale. Consequently, the character of the crust, the surface-markings or ornamentation, if any existed, and the original convexity of the head are all unknown; but there are indications that the

convexity of the head must have been considerable, and that the specimens have been much flattened by pressure. * When perfect specimens shall be discovered, they may probably necessitate a modification of the foregoing description, but it is believed that such discovery will not necessitate material change. The specimens of the collection are of various sizes, due to difference in age; the transverse diameter of the head being from one and a half to five and a half centimeters.

This species is nearly allied to *O. Vermontana* Hall, from strata in Northern Vermont, generally referred to the Potsdam epoch; but it differs in many respects, the following being among the more important differences that appear upon comparing our specimens with the figure and original description of that species:—

The frontal lobe of the glabella of our species does not reach the anterior margin of the head by a space nearly equal to one-third the length of that lobe, instead of coming in contact with the frontal margin as in *O. Vermontana*. The anterior ends of the eyes of our species reach forward nearly into contact with the anterior lobe of the glabella, being considerably farther forward than they are represented to reach in the figures of the Vermont species. In our species, the raised marginal rim of the posterior border of the head extends continuously across the occipital lobe of the glabella, but the figure and description of *O. Vermontana* represent no such raised rim. The posterior margin of the head of our species is rounded forward at the postero-lateral angles, while the figure of *O. Vermontana* represents the posterior border of the head as curving backward, and forming sharp, spine-like angles with the lateral margins. The short cheek-spines of that species are represented as widening at the base; in ours, the cheek-spines are longer, more slender, and do not thus widen. The long third pleura of *O. Gilberti* is not bent backward so abruptly as it is in *O. Vermontana*, and the former species seems also to have reached a larger size than the eastern one.

Position and locality.—Strata of the Primordial period, probably of the Potsdam epoch, Pioche, Nevada, and at Ophir City, Oquirrh range, Utah.

Olenellus Howelli Meek.

Plate II, fig. 4 a and b.

Olenellus Howelli Meek, 1874 (manuscript).*Olenellus Howelli* White, 1874, Geog. & Geol. Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 8.

Head massive, semi-oval in outline, strongly convex, the length on the median line being to the greatest breadth about as three to five; exterior margin having a strong, raised border, of nearly uniform width all around, and which is also continuous with the moderately strong spines of the postero-lateral angles of the head; length of the spines about equal to one-half the length of the head on the median line; posterior margin also having a raised border extending on each side from the occipital segment to the base of the spines, but not crossing the glabella upon the occipital lobe; width of this border not uniform like that of the exterior margin, but is widest a little beyond the midlength at each side, and narrowest near the base of each spine, toward which it again suddenly widens, blending with both the spine and the exterior raised border; this widening of the border there rounds the angle between the posterior margin and the spine, and also rounds the postero-lateral angle of that portion of the cheek which is inclosed within the raised borders. A shallow, linear depression extends around the head just within the raised border, giving the broad cheek-surfaces the appearance of being slightly inflated.

Eyes large, very prominent, extending from opposite the anterior furrow of the glabella to nearly opposite the middle of the occipital lobe; the palpebral lobe of each eye blending with the outer ends of the anterior, middle, and posterior lobes of the glabella.

Glabella large, very prominent, distinctly lobed; the furrows, while they are distinct at the sides, are only slightly impressed at the median line; occipital and posterior lobes of about equal size; frontal lobe large, tumid, well defined, extending forward to the shallow, linear depression just within the raised border of the anterior margin of the head, regularly rounded in front, a little wider than the remainder of the glabella, but not higher than the others of its lobes.

Surface apparently smooth but the condition of the specimen is such that this character is not clearly shown. Remainder of the body unknown, the only specimen discovered consisting of a well-preserved head alone. Associated with it, however; the spinous extremity of a pleura was found that possesses the characteristics of similar parts of *Olenellus*, and which probably belonged to an individual of this species.

This species is apparently related to *O. Thompsoni* Hall, from rocks in Northern Vermont referred to the Potsdam epoch, where it is associated with *O. Vermontana*; but it differs in general outline and proportions, and also in many details, as shown by comparison with the figures and original description of that species by Professor Hall. The frontal lobe of the glabella in *O. Howelli* is wider than those behind it, instead of being narrower than the hinder ones, as they are represented to be in *O. Thompsoni*. The details of the exterior and posterior raised margins are different, and the postero-lateral spines are not proportionally so strong in our species as they are represented to be in that one. The occipital furrow in ours does not extend so distinctly across the glabella as it does in *O. Thompsoni*, and the occipital lobe is proportionally wider, and extends farther backward than it does in that species. It is also related to *O. Gilberti*, but differs in general proportions of the head, the details of the exterior and posterior borders, and in the proportional size of the different lobes of the glabella.

As the genus *Olenellus* is held by geologists to mark a distinct and characteristic horizon in American strata, its discovery in that distant locality is peculiarly valuable and interesting. It is also an interesting and significant fact that the two species here described respectively represent in their specific characters the two originally-described species of the genus found associated in the Primordial rocks of Vermont and Canada, as these are found associated in rocks of the same period in Nevada.

The specimens from which the descriptions of the two species of *Olenellus* herein recorded were made are the same that were used by Mr. Meek in his original descriptions and naming of the species.

Position and locality.—Strata of the Primordial period, and probably of the Potsdam epoch, Pioche, Nevada.

VESTIGIA.

Plate I, fig. 6 *a* and *b*.

From the same strata that contain *Cruziana Linnarrsoni* and *C. rustica*, the collections contain some thin pieces of siliceous shale marked by a number of series of minute tracks that were probably made by some small Crustacean or other Articulate. They consist of double rows of slight transverse depressions upon the smooth surface of the shale, with a plain space between each series of the double row, about half as wide as the width of a series, but in some cases the two series of tracks constituting the double row nearly meet in the center. Each separate minute track or depression arches slightly, and, although very narrow, they are each nearly or quite as wide as the spaces between them are. In some portions, each separate depression appears as if it had been twice or thrice impressed with minute organs of locomotion of similar size and shape. The width of the double row is about three millimeters, and the transverse length of each separate impression or track is hardly more than one millimeter. There are about twelve impressions, or separate tracks, in the length of a centimeter.

The tracks pursue a slightly tortuous course; the longest series shown by the specimens in the collection having a continuous length of about six centimeters, but all of them are broken at both ends. No remains have been found associated with them that might indicate the characteristics of the animal that made them; but the narrowness and uniformity of the series, together with the fact that each separate minute track appears to have been repeatedly impressed by a series of similar organs of locomotion, seems to suggest vermiform characteristics, but it does not necessarily follow that the animal was a true worm.

The collections contain no other traces of animal life from these shales, and the formation has been referred to the Primordial period mainly upon stratigraphical grounds.

Position and locality.—Tonto shale, Primordial period; Grand Cañon of the Colorado River, Mohave County, Arizona.

CHAPTER IV.

CANADIAN PERIOD.

PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

GENUS RECEPTACULITES Defrance, 1827.

Receptaculites ——— (?).

The collections contain a single fragment only of one of these strange and interesting forms. It is too imperfect for specific characterization, but is noticed here to make the account as complete as possible of the faunal characteristics of the strata which I have referred to the Canadian period. It seems to be a fragment from near the base of one of those broad sac- or urn-shaped species such as have been described by Mr. Billings from strata of the same period in Canada. Both ectorhin and endorhin have been mostly removed by weathering, whereby the open ends of the numerous close-set cylindrical tubes that connected them are exposed.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

RADIATA.

CLASS HYDROZOA.

ORDER HYDROIDA.

FAMILY GRAPTOLITIDÆ.

GENUS PHYLLOGRAPTUS Hall, 1858.

Phyllograptus Loringi White.

Plate III, fig. 1 *a* and *b*.

Phyllograptus Loringi White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 9.

Stipe apparently having the usual quadripartite form of the genus; the foliate expansion having a somewhat irregular elongate-oval outline and a moderately narrow axis. Cellules leaving the axis at different angles with it in different parts of the stipe, ascending along the middle portion so as to form an acute angle with the axis, then sweeping outward with an increasing curvature to the lateral margins, where they are at right angles with the axis, or in some parts of the length of the stipe slightly recurving. Toward the apex, the cellules are less curved and form more acute angles with the axis. Each cellule gradually but slightly increases in size as it extends outward to the margin, where there are thirteen or fourteen in the space of a centimeter. Each cellule is provided at its aperture with a strong, prominent, recurving lower lip, the edges of which in our example, it being compressed, have somewhat the appearance of spine-like appendages. The stipe being broken at the lower end, the shape of that part is known only by inference, and for the same reason the full length has not been accurately ascertained, but it was apparently about four centimeters long; width, at about midlength, one and a half centimeters.

This species has the general aspect of *P. typus* Hall, but it differs from that species in the size of its cells and the character of its cell-apertures. According to Professor Hall, *P. typus* has a maximum of twenty-six cells

in the space of an inch, while our species has from thirty-four to thirty-six in the same space. That species is represented as having small mucronate appendages at the cell-apertures, which those of our species are destitute of, but are provided instead with a thickened projecting lower lip.

Dedicated to the memory of Mr. F. W. Loring, who was murdered by the Apache Indians in October, 1871, while a member of one of the exploring parties.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIPODA.

ORDER LYOPOMATA.

FAMILY LINGULIDÆ.

GENUS LINGULA Brugnière, 1789.

Lingula? *manticula* White.

Plate III, fig. 2 *a* and *b*.

Lingula? *manticula* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 9.

Shell small elongate-subovate or subelliptical in outline, broadest at or a little behind the middle; beaks pointed.

Dorsal valve proportionally wider than the ventral, moderately convex; postero-lateral margins nearly straight, meeting at the beak at an angle of nearly forty-five degrees; beak small, depressed; front margin regularly rounded.

Ventral valve proportionally longer than the dorsal in consequence of the considerable projection of its beak behind that of the dorsal valve; the whole valve, except its prominent beak, corresponding nearly with the whole of the opposite one, but its posterior portion is a little more convex transversely than any part of the other valve is; the beak is more prominent

and sharper, and the postero-lateral slopes straighter than they are in the dorsal valve. Surface of both valves having a smooth appearance, but fine concentric lines and obscure radiating striæ are to be seen under a lens.

Length of the dorsal valve represented by figure 2 *a*, Plate III, six millimeters; width, four millimeters. This is the largest valve the collections contain, but it is not improbable that the species attains a larger size.

This species in general aspect resembles *Lingula acuminata* Conrad, from the Calciferous sandstone formation of New York, especially in the narrowness of the posterior portion of the ventral valve and its slender beak; but it is not proportionally so broad anteriorly as that shell is, and in other respects the outline is materially different. The dorsal valve of our shell resembles the figure of a specimen that Professor Hall refers doubtfully to *Lingula mosia*, from the Potsdam formation of Wisconsin (Sixteenth Ann. Regent's Report New York State Cabinet, plate 6, figure 1); but the ventral valve of ours is proportionally longer than that figure, which is understood to represent a ventral valve. If this supposition is correct, that species has proportions materially different from those of ours.

I refer this species with doubt to the genus *Lingula*, because the internal characters of the shell are unknown, and because it is now generally admitted that among the linguloid shells of the older Paleozoic rocks, which were formerly referred to the genus *Lingula* without question, there are really several different genera, all distinct from the recent *Lingula*.

Position and locality.—Strata of the age of the Quebec group of Canada; Schellbourne, Schell Creek range, Nevada.

FAMILY DISCINIDÆ.

GENUS ACROTRETA Kutorga, 1848.

Acrotreta pyxidicula White.

Plate III, fig. 3 *a* and *b*.

Acrotreta pyxidicula White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 9.

Shell minute; marginal outline subcircular or transversely suboval; without observable mesial sinus or fold. Dorsal valve most prominent near the umbo; beak small, depressed, but well defined, hardly projecting

beyond the hinge-line; cardinal angles rounded; hinge-line short, nearly straight; lateral and front margins regularly rounded.

Ventral valve obliquely depressed-subconical; apex acute, prominent, and perforated by a minute foramen; margin in front of the hinge-line regularly rounded; area small, triangular, nearly flat, the angles which it forms with the sides of the shell rounded. Surface of both valves smooth, or marked by very fine concentric lines of growth.

Width, two millimeters; length a little less; height a little less than the length.

This species, although so minute, seems to be a well-marked one, and possesses all the usual external characteristics of *Acrotreta*, except that the ventral valve is not so capacious as it generally is in that genus. It differs from *A. gemma* Billings, from strata of the age of the Quebec group in Newfoundland, in the less proportionate height of the ventral valve, and in the absence of a mesial sinus in the dorsal valve.

Position and locality.—Strata of the age of the Quebec group of Canada; Schellbourne, Schell Creek range, Nevada.

ORDER ARTHROPOMATA.

FAMILY STROPHOMENIDÆ.

GENUS STROPHOMENA Rafinesque, 1827.

Strophomena fontinalis White.

Plate III, fig. 4 *a*, *b*, and *c*.

Strophomena fontinalis White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 10.

Shell moderately concavo-convex or nearly flat; outline semi-elliptical; width from one-quarter to one-third greater than the length; width at the hinge-line varying from a little more to a little less than it is just in front of the hinge. Ventral valve slightly convex or somewhat flattened; convexity greatest behind the middle. Dorsal valve slightly concave, and in other respects corresponding with the ventral. Hinge and interior of both valves unknown.

Surface of both valves marked by fine, uniform, rounded, radiating striæ, which increase by bifurcation, and give the surface an appearance

similar to that of the well-known *Strophomena fragilis* Hall, from the Devonian strata of New York and other States. Fine concentric striæ are also visible under a lens.

Length, eighteen millimeters; breadth, twenty-four millimeters.

This species resembles *S. recta* Conrad in outline, but the surface-markings are quite different. It also bears a general resemblance to *S. aurora* Billings, but differs in having rounded striæ of uniform size instead of the angular striæ of variable size which that species possesses.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

GENUS ORTHIS Dalman, 1828.

Orthis Electra Billings (?).

Among the collections made at Fish Spring, House range, Utah, from strata of the age of the Quebec group of Canada, are a few imperfect specimens of a species of *Orthis* that is very closely related to *O. Electra* Billings (Paleozoic Fossils of Canada, vol. I, page 79), if it is not identical with it. In outline, convexity, and the fine striation of the surface, our specimens agree closely with it, but the size is considerably greater than that given for *O. Electra*. The width at the hinge-line of the largest specimen is about sixteen millimeters.

MOLLUSCA VERA.

CLASS GASTEROPODA.

SUBCLASS DICEA.

ORDER RHIPHIDOGLOSSA.

SUBORDER DICRANOBRANCHIATA.

FAMILY BELLEROPHONTIDÆ.

GENUS BELLEROPHON Montfort, 1808.

Bellerophon allegoricus White.

Plate III, fig. 6 *a*, *b*, and *c*.

Bellerophon allegoricus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 10.

Shell not above medium size, rather compact, umbilicated; umbilicus

very small; aperture expanded, greatest expansion at the sides, giving it a reniform outline; outer volution abruptly convex transversely; lip having a moderately large deep notch in front, of uniform width, the sides being parallel, and rounded at the bottom; of equal width, and continuous with this notch, there is a slightly-elevated, rounded, dorsal band extending along the center of the volution until it enters the aperture. Surface-markings not preserved in any of the specimens of the collection.

Extreme width across the aperture, eighteen millimeters; postero-anterior diameter of the shell, seventeen millimeters.

Although the specimens are imperfect in some respects, they are sufficiently well preserved to show that they represent a species quite unlike any other known to me from any of the older Paleozoic rocks.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

CLASS CEPHALOPODA.

ORDER TETRABRANCHIATA.

FAMILY ORTHOCERATIDÆ.

GENUS ORTHOCERAS Breynius, 1732.

SUBGENUS CAMAROCERAS Conrad, 1842.

Orthoceras (Camaroceras) colon White.

Plate III, fig. 5 *a*, *b*, *c*, and *d*.

Orthoceras colon White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 10.

Shell annulated, very slightly tapering; transverse section oval; siphuncle large, peripheral, in contact with one of the broadly-rounded sides, its diameter equal to about one-third the short diameter of the shell; septa smooth; convexity nearly uniform, reaching farther forward at the narrower sides than at the broader ones; annulations broadly rounded, passing sinuously around the shell, the sinuosity being greater upon one of the broad sides than it is upon the other; interspaces nearly corresponding in width and curvature with the annulations. Surface-markings unknown.

Long diameter, eighteen millimeters; short diameter, fifteen millimeters; distance from center to center of the annulations, six millimeters.

The only specimen contained in the collections is the one figured on Plate III. It has the appearance of being slightly curved, as shown in figure 5 *c*, which, if natural, of course removes it from the genus *Orthoceras*; but, as the specimen has been a little compressed at one end, it is thought the curvature is due to that cause alone. If originally straight, as it is thought to have been, it properly belongs to the subgenus *Camaroceras* of Conrad, as is shown by the large peripheral siphuncle.

Numerous annulated species of *Orthoceras* have been published, but the one here described possesses characteristics that seem to clearly distinguish it from them all. Compared with *O. pulchrum* Barrande, it differs in having sinuated instead of direct annulations, an oval instead of a circular transverse section, and in having a larger siphuncle, which is also peripheral instead of central. From *O. annulatum* Sowerby, as figured and described by Barrande (not *Endoceras annulatum* Hall), it differs in its proportionally narrower annulations as compared with the interspaces, its oval instead of circular or nearly circular transverse section, and in its larger and peripheral instead of central siphuncle. From *O. dulce* Barrande, it differs in its oval instead of circular transverse section, and in its larger siphuncle, which is also peripheral instead of central. From *O. undulostriatum* Hall, it differs in the course of its sinuous annulations, which both species possess, and in its much larger and peripheral instead of central siphuncle. With *O. furtivum* Billings from the Calciferous formation of Canada, it is closely related in the character, size, and position of the siphuncle, but differs in its oval instead of circular transverse section, and also in the direction and character of the annulations.

Position and locality.—Strata of the age of the Quebec group of Canada; Fish Spring, House range, Utah.

FAMILY CYRTOCERATIDÆ.

GENUS CYRTOCERAS Goldfuss, 1833.

Cyrtoceras ———(?)

Among the collections from strata of the age of the Quebec group, at Fish Spring, House range, Utah, there is a specimen of *Cyrtoceras*, too imperfect for specific characterization, but which resembles in general aspect

C. metellus Billings, from the Quebec strata of Canada. The curvature and proportions are similar to those of that species, and the septa are equally numerous and close-set.

ARTICULATA.
CLASS CRUSTACEA.
ORDER OSTRACADA.
FAMILY CYPRIDINIDÆ.

GENUS *LEPERDITIA* Rouault, 1851.

***Leperditia bivia* White.**

Plate III, fig. 7, *a*, *b*, *c*, and *d*.

Leperditia bivia White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 11.

Shell not quite equivalve, inflated, the greatest transverse diameter being about midlength and below the middle; obliquely subovate in outline, widest behind the middle; the straight hinge-line about equal in length to two-thirds the entire length of the shell, and ending both posteriorly and anteriorly in a small, distinctly projecting angle, which it forms with the anterior and posterior margins respectively; posterior margin obliquely rounded, and provided with a moderately broad, somewhat flattened border; anterior margin abruptly rounded, having also a similarly-flattened border; the flattening of the borders of both valves and at both ends becoming obsolete upon reaching the ventral margin, which is broadly rounded; ventral border of the left valve bent sharply inward, and even a little upward, producing a narrow, plain, area-like surface there, which tapers to a sharp point at each end, and is nearly equal in length to the hinge-line; ventral border of the right valve not bent inward like that of the left, but the general convexity of the valve extends to the ventral edge. Upon the ventral border of this valve, near its edge, there are two distinct, comparatively large pores, which open divergently upon the surface; the

distance between them being equal to a little more than half the length of the hinge-line. Eye-tubercle not detected. Surface apparently smooth.

This species agrees nearly in size with, and bears a close general resemblance to, *L. Canadensis* Jones, from the Calciferous sandstone formation of Canada; but it may be readily distinguished from that species by the prominent angles at the ends of the hinge-line, the laterally-flattened anterior and posterior borders, the greater convexity below the middle, and by the presence of the two large pores at the ventral border of the right valve.

Position and locality.—Strata of the age of the Quebec group of Canada; Queen Spring Hill, Schell Creek range, Nevada.

Collected by Mr. J. E. Clayton.

ORDER TRILOBITA.

FAMILY ASAPHIDÆ.

GENUS MEGALASPIS Angelin, 1854.

Megalaspis belemnurus White.

Plate III, fig. 9.

Megalaspis belemnurus, White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 11.

Pygidium subtriangular in outline, moderately convex transversely, and only slightly convex along the median line; length compared with the width across its anterior end about as fifteen to twenty-two; each outer margin having a wide smooth border, the outline of which is only slightly convex except near the antero-lateral angles, where the convexity increases and the angles are abruptly rounded; anterior margin moderately convex; posterior extremity ending in a short spine-like process; segmentation somewhat indistinct, but is most apparent upon the anterior portion of the axis; trilobation also rather obscure; axis depressed, slightly higher than the adjacent portions of the lateral lobes, its width equal to about one-half the width of a lateral lobe, ending posteriorly in the elevated terminal portion of the pygidium; dorsal furrows moderately distinct upon the anterior half of the pygidium but become obsolete posteriorly; lateral lobes slightly

convex, indistinctly defined externally by the broad, nearly flat marginal border; their inner sides more clearly defined, especially their anterior portions, by the dorsal furrows. Surface apparently smooth; but this character, as well as the remainder of the body, is unknown.

Length of the pygidium from the front end to the base of the caudal spine, fifteen millimeters; width of the same between the antero-lateral angles, twenty-two millimeters.

This species is closely related to *Asaphus* (*Megalaspis*) *goniocercus* Meek; but it differs from that species in its less distinctly triangular outline, its greater proportionate width, its proportionally narrower axis, and rather more distinct dorsal furrows. In general aspect, the pygidium of our species resembles that of a *Dalmanites*, but the obscure trilobation and segmentation separate it from that genus. It has not so complete a consolidation of the component elements of the pygidium as *Asaphus* has; and no striation of the under surface of the marginal border has been observed, such as is common in the genus *Asaphus*.

Position and locality.—Strata of the age of the Quebec group of Canada; Queen Spring Hill, Schell Creek range, Nevada.

Collected by Mr. J. E. Clayton.

FAMILY ——— (?).

GENUS DICELLOCEPHALUS Owen, 1852.

Dicellocephalus? *flagricaudus* White.

Plate III, fig. 8 *a* and *b*.

Dicellocephalus flagricaudus White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 12.

Pygidium contracted-fan-shaped; lateral lobes each consisting of three segments directed backward; the inner one of each side lying close to the dorsal furrow, nearly parallel with the axis of the body or converging a little posteriorly, and becoming obsolete upon each side of a small, but comparatively wide, sloping border that extends around the posterior end of the axial lobe.

The middle pair of segments commence at the dorsal furrow of each

side respectively near the anterior end of the pygidium, bend abruptly, and extend backward parallel with the first, and project beyond the border as converging posterior spines. The third and outer pair of segments commence anteriorly at the dorsal furrows, where they are very narrow, extend outward a little, then curving abruptly backward they lie parallel with the others and form raised lateral margins of considerable but unequal width to the pygidium, and thence they extend posteriorly as an outer pair of converging spines. Axis prominent, especially at its apex, where it terminates in a moderately distinct angle, about one-quarter wider anteriorly than posteriorly, well defined by the nearly straight dorsal furrows, and marked by five or six distinctly defined segments, which cross it almost transversely, but with a slightly sinuous course.

Length of the pygidium along the median line, seven millimeters; greatest transverse diameter, nine millimeters.

The collections contain only the pygidium of this species, and I have therefore referred it doubtingly to *Dicellocephalus*, although it might perhaps, with equal propriety, be referred to *Amphion*. It has a general resemblance to the pygidium of *D. magnificus* Billings, and a still closer resemblance to *D. ? cora* Billings, from the Quebec group of Canada.

Position and locality.—Strata of the age of the Quebec group of Canada; Schellbourne, Schell Creek range, Nevada.

CHAPTER V.

TRENTON PERIOD.

RADIATA.

CLASS HYDROZOA.

ORDER HYDROIDA.

FAMILY GRAPTOLITIDÆ.

GENUS GRAPTOLITHUS Linnæus, 1736.

SUBGENUS CLIMACOGRAPTUS Hall, 1865.

Graptolithus (Climacograptus*) ramulus White.Plate IV, fig. 3 *a*, *b*, and *c*.

Graptolithus (Climacograptus) ramulus White, 1874, Exp. & Surv. west 100th Merid.,
Prelim. Rep. Invert. Foss., 13.

Stipe slender, bifurcating; bearing cells upon both edges below the bifurcation and upon one edge only (the outer) above that point, so that each series of cells is continuous from the common, proximal, extremity to the distal extremities of the branches respectively. The body of the stipe throughout is moderately thin and flat, but the cells are inflated so that their transverse diameter is considerably greater than the thickness of the stipe; cells moderately large, each bearing upon its outer wall about mid-

*I am inclined to think that the two groups into which Professor Geinitz has divided his genus *Cladograpsus* should be designated by separate generic or subgeneric names. In that case, it seems proper that his first group should retain the name *Cladograpsus*, which would replace *Climacograptus* of Professor Hall, while the second group seems to agree with *Didymograpsus* of Professor McCoy. Possibly, however, the peculiar character of the cells of the species above described may hereafter require a new generic designation.

height a slender outward-projecting spine. The cells are of peculiar shape, as shown in the enlarged figures on Plate IV, and their apertures appear to have been lateral, but of this I am not entirely satisfied. If they are so, it is rather remarkable that they are all upon one side, in view of the fact that bilateral symmetry of the stipe is so prevalent throughout the family.

This species has the general aspect of *G. ramosus* Hall from the dark shales at Norman's Kill near Albany, New York, and before its microscopic examination it was supposed to be identical with it. It is found, however, to differ very materially in the form of its cells and the character of the stipe, as may be seen by comparing our figures with those of *G. ramosus* on Plate A, Decade II, Geological Survey of Canada.

Among these differences, there is one at least that seems to modify its relation to the subgenus *Climacograptus*, and especially to that section of it to which *G. ramosus* is assigned by Professor Hall. This is the presence of inflated cells of irregular form, projecting from the general surface of the stipe, instead of having the cells short and square, and hollowed out of the body of the stipe,—characters which are understood to distinguish *Climacograptus*. Among the specific differences between our species and *G. ramosus* are the different proportions and shape of the cells, the presence of spines upon all of them in our species instead of upon a part only, and the position of the spines about midway instead above the cell-aperture as in that species.

Position and locality.—Shales, probably of the age of the graptolitic shales at Norman's Kill near Albany, New York; five miles north of Belmont, Nevada, where it is associated with the three following-described species.

SUBGENUS DIPLOGRAPTUS McCoy, 1850.

Graptolithus (Diplograptus) hypniformis White.

Plate IV, fig. 4 *a* and *b*.

Graptolithus (Diplograptus) hypniformis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 12.

Stipe simple, slender; sides flat; edges nearly straight and nearly parallel; the increase in width from the proximal or basal end toward the distal end being very slight, except near the base; serratures deep, narrow,

sharply rounded or angular at the bottom; inner and outer sides both rising at acute angles with the axis of the stipe, those of adjacent cells joining together to form moderately long, slender, mucronate points, which are directed strongly upward between the cells. At the basal end of the stipe small, downward-diverging points are sometimes seen, such as those possessed by *G. Whitfieldi* Hall, and other allied species; like those species also, ours has a slender, thread-like axis, passing longitudinally through the center of the stipe and extending beyond the distal cells; serratures, or cells, about twelve in the length of a centimeter, but they have the aspect of being somewhat more numerous, because of the narrowness of the cells occasioned by the acuteness of the angle which the cell-axes form with the axis of the stipe. Exterior width of the stipe between the mucronate points of each side often less than two millimeters, and seldom more. Length of stipe, from one to three centimeters.

Upon the pieces of graptolitic shale in the collections are numerous stipes doubtless belonging to this species, but most of them have their details of structure so far obscured that it is difficult to distinguish them; the mucronate points between the cells, being delicate, are often removed, in which case the serratures have a blunted appearance. The more perfect stipes have somewhat the aspect of portions of those of *Hypnum*, or other related mosses, which circumstance has suggested the specific name.

This species is related to *G. Whitfieldi* Hall from the graptolitic shales at Norman's Kill near Albany, New York; but the prolongations of the cell-walls are mucronate, pointing upward, in ours, and not setæform, pointing outward, as in that species. Ours is also a smaller and more slender species, and has proportionally narrower cells.

Position and locality.—Shales, probably of the age of those at Norman's Kill, near Albany, New York; five miles north of Belmont, Nevada, where it is associated with the last described, and also with the two following species.

Graptolithus (Diplograptus) pristis Hall, (?)Plate IV, fig. 2 *a* and *b*.*? Prionotus pristis* Hisinger, 1837, *Lethæa Suecica*, 114.*Graptolithus pristis* Hall, 1847, *Paleontology of New York*, i, 265.

Stipe flattened; outline of the broader sides sublinear or very elongate-oblongate; cells moderately large, their upper sides or apertures being transverse and the outer sides sloping directly downward and inward gives the edges of the stipe a distinctly dentate appearance as it is compressed in the shale. Like related species, this has a slender thread-like axis passing longitudinally through its middle and extending beyond the distant cells.

In my preliminary report on these collections, this species was confounded with *G. quadrimucronatus* Hall?; fragments of the two species being mingled in the same pieces of shale. This circumstance modified my description of that species, but the correction is made in this report from the study of more perfect specimens. Our examples show some differences from the typical forms of *G. pristis*, but they correspond so nearly with them that I do not at present feel warranted in proposing a separate specific name.

Position and locality.—Shales of the Trenton period, probably of the Utica epoch; five miles north of Belmont, Nevada, where it is associated with the two species last described, and also with the following one.

Graptolithus quadrimucronatus Hall (?)Plate IV, fig. 1 *a* and *b*.*Graptolithus quadrimucronatus* Hall, 1865, *Geol. Surv. Canada*, decade ii, 144.*Graptolithus quadrimucronatus?* White, 1874, *Exp. & Surv. west 100th Merid.*, Prelim. Rep. Invert. Foss., 13.

Stipe quadrilateral, transverse section oblong, gradually but slightly increasing in diameter from the proximal or basal end to about midlength, where the maximum size is reached; cells opening on the two narrower sides of the stipe; their apertures opening obliquely upward, being narrow, transverse, four-sided slits of uniform size, about half as wide as the interspaces, their length equaling the full diameter of the stipe; the outer corner of each cell-aperture provided with a minute projecting point.

The specimens of the collection are all compressed upon shale; but there are among them examples of stipes compressed in the various postures they happened to assume when prostrated. These enable us to make out the structure as above indicated with comparatively little difficulty. Without bearing in mind the quadrilateral form of the stipe, one may mistake the confusion of details which the laterally-compressed specimens exhibit for examples of two stipes of an ordinary *Diplograptus* lying parallel and compressed together; but the adjustment and uniformity of the parts show that they all belong to a single body.

This species, so far as can be determined from the specimens of the collection, is so closely like *G. quadrimucronatus* Hall, from the "Utica slate formation, Lake Saint John, east from Blue Point", that I prefer to assign it provisionally to that species rather than to a new one. Our specimens, however, are more delicate and slender, and the mucronate points much less conspicuous than they are in the typical forms. The cells are also a little more prominent and the cell-apertures proportionally wider vertically.

Position and locality.—Shales, probably of the age of those at Norman's Kill, near Albany, New York; five miles north of Belmont, Nevada, where it is associated with the three species last described.

CLASS ACTINOZOA.

ORDER ZOANTHARIA.

FAMILY FAVOSITIDÆ.

GENUS MONTICULIPORA d'Orbigny, 1850.

Monticulipora Dalii Edwards and Haime.

Plate IV, fig. 5.

Chatetes Dalii Edwards et Haime, 1851, Monographie des Polypiers Fossiles, 266.

Coral dendroid; the branches cylindrical, six or eight millimeters in diameter; surface marked by small, slightly-raised mammillations, distant two or three times their own diameter from each other; calyces subequal in size, about one-quarter of a millimeter in diameter.

Our specimen presents no material difference from the figures and description given by Edwards and Haime, and it evidently belongs to that species. Their type-specimens were obtained by de Verneuil from strata of the Trenton period in Ohio.

Position and locality.—Strata of the age of the Trenton period; Silver Cañon, Pahrnagat range, Nevada.

GENUS FAVOSITES Lamarck, 1816.

Favosites ——— (?).

Among the collections are some specimens of *Favosites* that were obtained from strata of the Cincinnati epoch, both at Silver City and Upper Mimbres Mining Camp, New Mexico. They have been mostly silicified, by which change their wall-pores and other minute details of structure have been obliterated.

The specimens have the general aspect of *F. Gothlandica*, and, indeed, of several other admitted species also. But in view of the small number of characteristics possessed by even well-preserved specimens of this genus that may be relied upon for specific discrimination, and also of the imperfect condition of the specimens contained in the collections, no specific designation is given them.

FAMILY THECIDÆ.

GENUS FAVISTELLA Hall, 1847.

Favistella stellata Hall.

Plate IV, fig. 6 *a*, *b*, and *c*.

Favistella stellata Hall, 1847, Paleontology of New York, i, 275.

Columnaria alveolata Edwards et Haime, 1851, Monographie des Polypiers Fossiles, 309.

Favistella stellata Hall, 1862, Geol. Wisconsin, i, 430.

avist ella stellata Dana, 1862, Manual Geol., 220; *ib.*, 2d ed., 1874, 204.

Coral forming an irregular compact or subhemispherical mass; cells varying in diameter from two to four millimeters, the average being about three millimeters; the number of sides of each cell also varying from four to seven; diaphragms numerous, flat, or nearly so, at their central portions, but are bent downward a little at their margins, where they join the

vertical walls, which gives them the appearance of being slightly convex; some ten or twelve rays, or dissepiments, extend upon the surface of each diaphragm, from the walls to its center; walls well developed and vertically striated as if by undeveloped rays.

I am unable to perceive any specific difference between the specimens contained in the collections and those which I have collected from the localities that furnished Professor Hall with the type-specimens of the species.

Not having the means at hand for making a critical investigation of the grounds upon which Edwards and Haime referred this species to *Columnaria alveolata* Goldfuss, rejecting both the genus and species as established by Professor Hall, I make use of the names given by the last-named author. I do this with little hesitation, not only for the reason just stated, but also because the fossil under consideration is widely known and generally recognized by that designation among American geologists.

The specimens of the collection are all silicified, by which means they have lost some of their finer markings and details of structure; but a few of the cells are in a fine state of preservation.

Position and locality.—Strata of the Trenton period, Cincinnati epoch; Silver City, New Mexico.

FAMILY CYATHOPHYLLIDÆ.

GENUS ZAPHRENTIS Rafinesque et Clifford, 1820.

Zaphrentis ——— (?).

Some specimens of *Zaphrentis* were also obtained from the strata of the Cincinnati epoch, at Silver City, New Mexico. They are either too imperfect or possess too few characters to distinguish them specifically, and they are noticed only for their generic value in a faunal summary of the strata of that region that I have referred to the Trenton period.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY STROPHOMENIDÆ.

GENUS STROPHOMENA Rafinesque, 1827.

Strophomena filitexta Hall.

Plate IV, fig. 8.

Leptæna filitexta Hall, 1847, Paleontology of New York, i, 112.

Strophomena filitexta Hall, 1859, 12th Reg. Rep. N. Y. State Cab., 70.

Strophomena filitexta Meek, 1873, Paleontology of Ohio, i, 83.

Shell a little above medium size compared with other species of the genus; concavo-convex, semi-oval or subsemicircular in outline; widest at the hinge-line, or, in rare cases, a trifle narrower there than it is a little farther forward; sides generally forming an angle of about forty or forty-five degrees with the hinge-line; lateral and front margins continuously rounded, with a nearly semicircular curve.

Dorsal valve depressed or flattened in the umbonal region, but somewhat regularly arching from that part to the front and lateral margins; beak hardly distinguishable as such; area very narrow, projecting directly backward.

Ventral valve broadly concave, except near the beak, where it rises into a slight convexity; beak small, not prominent; area moderately high, its posterior or outer border sloping a little laterally but not forming an acute angle at the hinge-extremity with its cardinal or inner margin; foramen triangular and closed by a prominent pseudo-deltidium; hinge-teeth well developed; dental laminae continuous from the bases of the teeth with a prominent ridge, which almost or entirely encircles the concave depression occupied by the muscular scars; this depression sometimes having a narrow ridge extending longitudinally through its middle; cardinal margin of the

area sharp; anterior and lateral margins of the valve thickened and roughened by the vascular markings, which are much less distinct within the thickened border than they are upon it.

Surface of both valves marked by fine, close-set, radiating striæ, often of somewhat unequal size, the smaller ones being those that are implanted at various distances from the beak between those that are continuous from it to the margins; under a lens, the radiating striæ are seen to be finely crenulated by the crossing of numerous delicate concentric striæ.

Compared with authentic specimens of *S. filitexta*, and also with those of associated species to which it is closely related, our specimens correspond most nearly with those of the species to which they are here referred, although they present some slight differences.

Length, twenty-two millimeters; breadth, thirty-four millimeters.

Position and locality.—Strata of the Trenton period, Cincinnati epoch; Silver City, New Mexico.

GENUS LEPTÆNA Dalman, 1828.

Leptæna sericea Sowerby(?).

Plate IV, fig. 7.

Among the fossils collected at Silver City, New Mexico, from strata that are unmistakably referable to the Cincinnati epoch, are a few imperfect specimens of *Leptæna* that I refer with some doubt to the species generally recognized in America as *L. sericea* Sowerby. The specimens are too imperfect to base a specific description upon, but enough is shown to indicate that if they are not specifically identical with *L. sericea*, they belong to a closely-related and representative species.

GENUS ORTHIS Dalman, 1828.

Orthis occidentalis Hall.

Plate IV, fig. 11 a and b.

Orthis occidentalis Hall, 1847, Paleontology of New York, i, 127.

Orthis sinuata Hall, ib., 128.

Orthis subjugata Hall, ib., 129.

Orthis occidentalis Meek, 1873, Paleontology of Ohio, i, 96.

Shell moderately large, suboval or subquadrate in outline, the trans-

verse diameter being greater than the longitudinal; dorso-ventral diameter comparatively small in young shells, but it increases with age, so that some old shells are very ventricose; hinge-line sometimes a little less than the greatest width of the shell, but generally about equaling it; usually, the antero-lateral margins are regularly rounded and the front a little emarginate; postero-lateral margins generally almost straight from about the mid-length of the shell to the extremities of the hinge-line, with which they form more or less distinct angles.

Dorsal valve more convex than the ventral, even in the young, and it increases in convexity with age more than the ventral valve does; greatest convexity at or behind the middle, an indistinctly-defined longitudinal depression, or mesial sinus, is observable in many shells, but in some it is absent, even at the front margin, and is represented only by a slight flattening of the valve in the visceral region; umbo prominent; beak abruptly incurved; area moderately wide in the middle, narrowing to acute points at the extremities of the hinge-line, concave transversely; foramen broad at base, triangular.

Ventral valve broadly convex, convexity greatest near the beak; sides very slightly convex transversely; mesial sinus scarcely defined on the posterior half of the valve, but in front it consists of a broad, usually very shallow depression, which becomes obsolete about the middle of the valve; beak moderately prominent; area a little wider than that of the dorsal valve, and, like that area, it ends in acute angles at the extremities of the hinge-line; this area less arcuate than the other, sometimes arching a little backward, sometimes vertical with the plane of the valve, and sometimes inclining a little forward; foramen triangular, a little higher than wide, extending to the apex of the beak.

Surface of both valves marked by distinct, prominent, radiating striæ, which increase both by implantation and bifurcation, and are crossed by a few concentric lines of growth.

Mature specimens average about two and a half centimeters in length and three centimeters in breadth. The more gibbous specimens of that size sometimes reach nearly two and a half centimeters in dorso-ventral diameter.

Several varieties of *O. occidentalis* have been described as distinct species. Those of the collections agree well with the typical forms of the species, but it is not unlikely that future examinations of the strata from which they were collected will reveal associated varietal forms similar to those of the typical localities. This shell is one of the most common of those which characterize the rocks of the Cincinnati epoch, having been found in strata of that age in Ohio, Indiana, Illinois, Iowa, and Wisconsin, at which places it is understood to prevail in, if it is not confined to, the upper part of the group.

Position and locality.—Strata of the Trenton period, Cincinnati epoch; Silver City, Nevada.

***Orthis testudinaria* Dalman (?).**

Associated with the foregoing at Silver City, New Mexico, some imperfect specimens of an *Orthis* were obtained that very closely resemble *O. testudinaria*, but they are not sufficiently perfect to allow of a satisfactory determination of their specific identity. Their association in the strata there with species that are undoubtedly identical with the common associates of *O. testudinaria* elsewhere adds force to the supposition that our specimens belong to that species.

***Orthis plicatella* Hall (?).**

Plate IV, fig. 10 *a*, *b*, *c*, and *d*.

Orthis plicatella Hall, 1847, paleontology of New York, i, 122.

Orthis plicatella Meek, 1873, paleontology of Ohio, i, 108.

Shell rather small suboval or somewhat semi-elliptical in outline, wider than long; length of hinge-line generally a little less than the greatest breadth of the shell; sides regularly rounded to the front, which is broadly rounded with an elliptical curve.

Dorsal valve not quite so convex as the ventral, most prominent about the middle; beak depressed; area directed backward, narrow at the middle, and diminishing to a point at each hinge-extremity; foramen triangular, broad at its base, comparatively large; muscular scars not distinctly defined, but are separated by a comparatively broad, slightly-raised, medial ridge; cardinal process small, narrow, wedge-shaped, the larger end inward, not filling the foramen; cardinal sockets small; brachial processes moderately

strong, supported by a thin lamina in young shells, and by a still greater thickening of shell-substance beneath them in older ones.

Ventral valve gently arching from beak to front, and also from side to side; greatest convexity near the beak, which is abruptly pointed and projects backward beyond the hinge-line; area wider than that of the dorsal valve, and like that area it diminishes to a point at each extremity of the hinge; foramen triangular, extending to the apex of the beak.

Surface of both valves marked by strong, elevated plications, which are slightly flattened, or have a narrow linear depression along the back, each interspace also having a corresponding slender, slightly-raised line along its middle. So far as observed, all the plications extend without interruption from the umbonal region of each valve to the margins. The plications are shown distinctly upon the inner surface of the valves, especially at the margins, where also slight linear depressions are seen that mark the places of the raised lines between the plications on the outer side. Very fine concentric striæ are visible under a lens upon the outer surface, which, in consequence of erosion probably, are usually more distinct between the plications than upon them.

This shell is referred with doubt to *O. plicatella* Hall. It agrees with that shell in general characters, and yet it presents differences that are at least as great as those which separate *O. fissicosta* Hall from *O. plicatella*. It is also much like *O. tricenaria* Conrad in some of its features, but seems to differ from that shell as much as from *O. plicatella*. The differences from the latter are the continuity of all (?) the plications from the umbonal region to the margin without bifurcation or implantation, the slight flattening or depression of the back of each plication, and the presence of the slightly-raised lines at the bottom of the interspaces. Since the species is known to be a variable one, I am disposed to regard these differences as only varietal until further comparisons can be made.

Length of one of the largest specimens in the collection, fifteen millimeters; breadth, eighteen millimeters; distance from center to center of the plications at the front margin, about one and a half millimeters.

Position and locality.—Strata of Lower Silurian age, probably of the Trenton period; Fossil Butte, near Hico, Nevada.

Orthis biforata Schlotheim, var. *lynx*.Plate IV, fig. 9 *a* and *b*.

Shell nearly equivalve; width exceeding the length; hinge-line varying in length from a little greater to a little less than the greatest width of the shell, usually a little less; cardinal extremities generally more or less prominent in either case; cardinal area present and nearly alike in both valves; they are narrow, well defined, each having a triangular foramen; dorso-ventral diameter varying with age from equal to one-half the transverse diameter to the full extent of the same; in the latter case, the shells have a compact subglobose form.

Dorsal valve having a prominent, well-defined mesial fold, sometimes a little rounded but often quite angular, narrow, but distinct at the beak, and rapidly increasing in width toward the front; lateral portions convex transversely, and regularly arching from front to rear; beak not prominent, but arching over the area, and nearly meeting its fellow of the opposite valve.

Ventral valve about equally capacious with the dorsal; convexity of its sides similar to that of the sides of the dorsal valve, having a deep sinus corresponding with the elevated mesial fold of the other valve; its beak also similar in size, prominence, and incurvature to that of the dorsal valve.

The surface of each valve is marked by from eighteen to twenty-six strong, usually angular, plications, either three or four of which are at the bottom of the mesial sinus, and either four or five of them upon the mesial fold. The plications at each side of the mesial fold and sinus are similar in character to the others; all being usually simple, or continuous from the beak to the margin.

Length, about twenty-five millimeters; breadth, about thirty-three millimeters.

Several varieties of this exceedingly variable species, both in this country and Europe, have been described as distinct species. Its geographical distribution being very great, and notices and descriptions of it having been published at various times and places during more than one hundred and fifty years, its synonymy has attained unusual magnitude and diversity.

It is too voluminous for transcription here, and the reader is referred to the great works of Davidson on the Fossil Brachiopoda for the most complete exhibition of it yet published. The specimens contained in the collection are all referred to the variety generally known as *Orthis lynx* Eichwald.

Position and locality.—Lower Silurian strata of the Cincinnati epoch; Silver City, New Mexico, where it is associated with equally well-known forms of that epoch.

FAMILY RHYNCHONELLIDÆ.

GENUS RHYNCHONELLA Fischer, 1809.

Rhynchonella argenturbica White.

Plate IV, fig. 12 *a, b, c, d,* and *e.*

Rhynchonella argenturbica White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 14.

Shell somewhat less than medium size, compact, subtrihedral in outline; length and width nearly equal; maximum height in old shells nearly equal to the width; postero-lateral margins somewhat straightened or slightly convex; rostral angle from forty to forty-five degrees; antero-lateral margins rounded; front, viewed from the dorsal or ventral side, either sinuous or truncate.

Dorsal valve more convex than the ventral, abruptly arching behind the middle; break strongly incurved; mesial fold very prominent, distinctly defined even to the umbo, divided into either three or four prominent angular or sharply-rounded plications; sides regularly arching to the margins, both longitudinally and transversely, but become somewhat laterally flattened near the beak; each side marked by from four to seven plications, those nearest the mesial fold being of about the same size as those upon it, but they become smaller toward, and obsolete upon, the postero-lateral margins.

Ventral valve less capacious than the dorsal, and also less strongly arched; beak prominent; mesial sinus deep, occupying about one-half the width of the shell at the front margin, its sides abrupt and its bottom bearing either two or three plications like those of the dorsal fold; sides sloping away from the edges of the sinus with less convexity than the sides of the

dorsal valve have, and become laterally compressed near the beak; plications about seven on each side of the sinus, becoming smaller toward, and finally obsolete at, the postero-lateral regions. Both valves have the plications distinctly defined to the beaks, and, being sharply angular at the front, they give the margin there a sharply zigzag appearance. Besides the plications, the surface of both valves is marked by regular and distinct lines of growth, which appear more prominent upon the plications than between them, giving them a delicately-knotted or crenulated appearance in some shells.

Length and breadth, each about ten millimeters; height, about eight millimeters.

Separated valves of this species somewhat resemble those of *R. sub-trigonalis* Hall, and also, to a less extent, *R. Anticostiensis* Billings. From the first, it differs in its more compact form and its more elevated mesial fold; from the latter it differs, in similar particulars, and also in its greater approach to an angular outline.

Position and locality.—Lower Silurian strata of the Cincinnati epoch; Silver City and Upper Mimbres Mining Camp, New Mexico.

CLASS CONCHIFERA.

ORDER HETEROMYARIA.

FAMILY MYTILIDÆ.

GENUS MODIOLOPSIS Hall, 1847.

Modiolopsis ———(?).

Among the collections made at Upper Mimbres Mining Camp, New Mexico, are some specimens of a Conchifer that evidently belong to the genus *Modiolopsis* Hall. They are too imperfect for specific characterization, and are noticed only for their generic value in stratigraphical determinations, and for the purpose of giving a full account of the fossils collected at that interesting locality.

CLASS GASTEROPODA.

SUBCLASS DICECA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY MACLURÆIDÆ.

GENUS MACLUREA Le Sueur, 1818.

Maclurea ——— (?).

On Amargosa range, at the head of Amargosa Desert, Nevada, a single specimen of *Maclurea* was found in a mass of rock not *in situ*. Like the species last noticed, it is too imperfect for specific determination, and is noticed here only because of the value the genus possesses in stratigraphical determinations. The mass of rock in which it was found had not probably been far removed from its original position, and therefore the presence of Silurian strata in that neighborhood is inferred.

FAMILY PLEUROTOMARIIDÆ.

GENUS RAPHISTOMA Hall, 1847.

Raphistoma trochiscus Meek.

Plate IV, fig. 13 *a*, *b*, and *c*.

Euomphalus (*Raphistoma*?) *trochiscus* Meek, 1870, Proceed. Phila. Acad. Sci., 61.

Shell small, sublenticular; spire very slightly convex; suture not distinct; volutions three or four, flattened-convex both above and below, thin and sharply rounded at the outer side; inner or umbilical side not so sharply rounded as the outer; the inner third of the upper side impressed to receive the outer portion of the broadly-rounded lower side of the next volution within. The inner edges of the volutions are separate from each other within the umbilicus, but the outer edge of each is so nicely joined upon the next outer one that the convexity of the outer part of the upper side of each volution forms a part of the continuous convexity of the spire.

Width of the umbilicus about equal to the transverse diameter of the aperture, which is a little greater than one-third of the full transverse diameter of the shell.

Transverse diameter of the shell, nine millimeters; height of same, two and a half millimeters.

This shell differs slightly from the species as described and figured by Mr. Meek (*loc. cit.*), but it is probable that it is not specifically different.

Position and locality.—Silurian strata, probably of the Trenton period; Ewell's Spring, Arizona (lower horizon).

CHAPTER VI.

CARBONIFEROUS AGE.

SUBCARBONIFEROUS PERIOD.

RADIATA.

CLASS ACTINOZOA.

ORDER ZOANTHARIA.

FAMILY FAVOSITIDÆ.

GENUS FAVOSITES Lamarek, 1816.

Favosites divergens White and Whitfield.

Plate V, fig. 4.

Favosites —— White and Whitfield, 1862, Proc. Boston Soc. Nat. Hist., viii, 306.*Favosites divergens* White and Whitfield, 1862 (manuscript).*Favosites divergens* Winchell, 1865, Proc. Acad. Nat. Sci. Phila., 112.*Favosites Whitfieldi* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 15.

Coral irregularly flattened-convex or subhemispherical; cells abruptly diverging from the base, increasing interstitially; apertures unequal in size, the smaller ones being those of beginning interstitial cells; vertical walls comparatively strong; diaphragms thin, about three within a space equal to the diameter of a cell. Diameter of cells from two to three millimeters.

The only specimen which the collection contains is silicified and partly imbedded in limestone, so that the finer details of structure have been obscured; but it is sufficiently perfect to indicate with little or no doubt its identity with *F. divergens*. So far as I am aware, no other species of this genus has been discovered in the Subcarboniferous rocks of North America, nor in any rocks of later than Devonian age. This statement is made upon the supposition that *Favosites? mancus* Winchell from the Goniatite limestone of Indiana is not a true *Favosites*. The type-specimens of this species were obtained from the Subcarboniferous strata at Burlington, Iowa, where

it is rare. When the description of the species was first published, the specific name was inadvertently omitted, but was added in manuscript to the copies of the memoir that were separately distributed. When publishing the preliminary report upon these collections, it was my intention to compliment my friend by giving his name to the species; but, finding that the manuscript name had been used in the publications of Professor Winchell, I erased the personal name and restored the original one, but the the typographical correction was inadvertently omitted.

Position and locality.—Strata of the Subcarboniferous period; Ewell's Spring, Arizona (upper horizon), where it is associated with the two following species.

GENUS SYRINGOPORA Goldfuss, 1826.

Syringopora Harveyi White (?)

Among the fossils collected from the Subcarboniferous strata at Ewell's Spring, Arizona (upper horizon), there are a few examples of *Syringopora*. Their specific characters, indefinite enough in the most perfect specimens of the genus, are obscured by being imbedded in hard siliceous limestone. They closely resemble *S. Harveyi* White from the Kinderhook formation of the Subcarboniferous period at Burlington, Iowa, and, as no other species of the genus is known to me in that horizon, they are referred to the species named.

CLASS ECHINODERMATA.

ORDER BLASTOIDEA.

FAMILY PENTREMITIDÆ.

GENUS GRANATOCRINUS Troost, 1850.

Granatocrinus lotoblastus White.

Plate V, fig. 3 *a* and *b*.

Granatocrinus lotoblastus White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 15.

Body subelliptical in outline by side-view; greatest breadth about the middle; distinctly but not very deeply pentalobate at the base, truncate at top; base depressed; basal plates very small; radial plates apparently very short, and embracing only the lower extremities of the pseud-ambu-

lacr al areas; interradial plates long and narrow, apparently reaching the summit; a comparatively shallow vertical furrow extending along the middle of each; pseud-ambulacral areas prominent, narrow, reaching down to, or below the plane of, the basal plates.

Our only example is silicified and partly imbedded in siliceous limestone, whereby the finer details of structure and ornamentation, including the structure of the parts at the anal side of the summit, are obscured; but the more conspicuous features are sufficient to indicate its specific separation from any similar form known to me.

Height, nine millimeters; transverse diameter, seven millimeters.

In general aspect, this little *Granatocrinus* is much like *G. melo* (= *Pentremtes melo* Owen and Shumard) from the Subcarboniferous strata at Burlington, Iowa; but it differs from that species in its less robust form, and in not possessing the distinct longitudinal lobes that suggested to those authors its specific name.

In that species also, the pseud-ambulacral areas are more or less depressed below the general surface of the interradial plates, while in ours those parts are the most prominent portions in the outline of a transverse section of the body. If the generic identification of this fossil as distinct from *Nucleocrinus* is correct, as it is believed to be, there seems to be no reason for questioning the Subcarboniferous age of the strata containing it, since the genus as thus restricted is understood to be confined to strata of that period alone. The Subcarboniferous age of the strata is also indicated by other types of that period associated with this species.

Position and locality.—Strata of the Subcarboniferous period; Ewell's Spring (upper horizon), Arizona.

ORDER CRINOIDEA.

FAMILY PLATYCRINIDÆ.

GENUS PLATYCRINUS Miller, 1821.

Platycrinus — (?).

Plate V, fig. 2.

Upon the weathered surface of a piece of limestone in the collections, there are three or four more or less imperfect Crinoids. They are partly

imbedded in the limestone, and partly defaced by weathering. One of these is a *Platycrinus*, as shown by characters other than the body-plates, the exact outlines of which are obscured by the injury the specimen has suffered. The outline of the calyx is shown, however, being broad cup-shaped, the base slightly depressed at the middle; arms bifurcating two or three times; branches of arms slender; the whole upper part of the body prolonged into a proboscidiiform dome, which has a height equal to about three times that of the calyx, and stands erect between the arms; stem slender, composed of joints of unequal size.

Breadth of the calyx about eight millimeters; height, five millimeters; height from base of the calyx to the top of the proboscidiiform dome, two centimeters; the arms were capable of being extended nearly a centimeter farther. The apparent breadth of the calyx has possibly been increased a little by pressure; but the general proportions have evidently not been much changed.

This species is a delicate one in all its parts. Except that it is not nearly so robust, nor so large, it resembles *P. levis* Miller, as figured by de Koninck and le Hon (Recher. Crinoides du Terr. Carb. de la Belgique). Judging from the general features of the fossil and such details as its condition allows of being observed, it seems to belong to an undescribed species, but of this I am not entirely satisfied. In case the discovery of more perfect specimens should show the species to be new, I propose for it the name of *P. vexabilis*.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

FAMILY ACTINOCRINIDÆ.

GENUS ACTINOCRINUS Miller, 1821.

Actinocrinus viaticus White.

Plate V, fig. 1.

Actinocrinus viaticus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 16.

Body below the arms broadly turbinate; arms slender, somewhat flattened laterally, apparently numbering thirty in all, the two full rays and

one-half of another shown by the specimen bearing such proportionate numbers. The appearance of branching of the arms begins below the periphery of the body, where, starting as if for simple pairs, they almost immediately bifurcate, the two inner branches of the two pairs thus formed again bifurcating at or just beyond the periphery, the two outer branches of each original pair remaining simple. Surface of the body-plates marked by sharp, radiating ridges, which give the whole surface below the arms a confused, cancellated appearance.

Breadth of the body at its periphery, about eighteen millimeters.

The body of this species resembles in general aspect that of *A. proboscidualis* Hall, and also that of *A. asperimus* Meek and Worthen, both from the Subcarboniferous limestone at Burlington, Iowa; but it differs from both in shape, in its more delicate surface-ornamentation, and in the different character and branching of the arms.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY PRODUCTIDÆ.

GENUS PRODUCTUS Sowerby, 1812.

Productus parvus Meek and Worthen.

Plate V, fig. 6 a and b.

Productus parvus Meek and Worthen, 1866, Geol. Surv. of Illinois, ii, 297.

Shell small, subhemispherical, length and breadth about equal; length of hinge-line nearly or quite equal to the greatest breadth of the shell; margin regularly rounded from ear to ear by the convexity of the shell.

Ventral valve regularly convex, without central flattening or mesial

sinus; beak slightly incurved over the hinge-line; ears small; surface marked by fine, distinct, uniform striae, about two within the space of a millimeter, increasing in number by occasional bifurcation, rarely by implantation; faint concentric wrinkles are observable upon the posterior half, especially near the beak, and fine concentric striae are also to be seen under a lens. A few small erect spines are scattered over the surface of the ventral valve, but they become broken off in the imbedding rock, and their bases do not form a conspicuous surface-feature of the shell.

Length in a straight line from beak to front margin, twelve millimeters; breadth, fourteen millimeters; convexity, about nine millimeters.

Meek and Worthen's type-specimens of this species were obtained from the Chester limestone of the Subcarboniferous period at Chester, Illinois, and, so far as I am aware, the species has never been recognized elsewhere except at the locality that furnished examples to these collections. Compared with the figures and original description given by those authors, our shell is found to differ in no material characters from theirs; while compared with other known species of similar size and general aspect, they are found to possess characters that clearly separate them from our species. This species has a general resemblance to *P. elegans* Norwood and Pratten, also from the Chester limestone, *P. arcuatus* Hall, from the Burlington limestone, both of the Subcarboniferous group; and also to some varieties of *P. longispinus* Sowerby, from the Coal-Measure strata. It is most nearly related to a variety of the last-named species which is found in considerable numbers near Santa Fé, New Mexico. In those shells, there is, however, more or less of a mesial flattening of the ventral valve; the ears also are more flattened and the hinge-line more extended than in the species under consideration.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

FAMILY STROPHOMENIDÆ.

GENUS STROPHOMENA Rafinesque, 1827.

Strophomena rhomboidalis Wilckins, * *sp.*

Plate V, fig. 5.

- Conchita rhomboidalis* Wilckins, 1767, Nachricht von selt. Verst., 77.
Anomites rhomboidalis Wahlenberg, 1821, Acta Societat. Scient. Upsal. viii, 65.
Productus depressa Sowerby, 1823, Mineral Conchology, v, 86.
Leptæna rugosa Dalman, 1826, Kongliga Vetens. Akad. Handl., 106.
Leptæna tenuistriata Sowerby, 1839, Silurian System, 623, 636.
Strophomena depressa Vanuxem, 1842, Geol. Third District New York, 79.
Orthis depressa Portlock, 1843, Geol. Lond., Tyrone, & Ferm., 450.
Leptæna tenuistriata Hall, 1847, Paleontology of New York, i, 108.
Strophomena rhomboidalis Lindstrom, 1860, Gothl. Brach., 371.
Strophomena rhomboidalis Hall, 1867, Paleontology of New York, iv, 76.
Strophomena rhomboidalis Davidson, 1868, Trans. Geol. Soc. Glasgow, Paleoz. Ser., i, 16.
Strophomena rhomboidalis Meek and Worthen, 1868, Geol. Surv. Illinois, iii, 426.
Strophomena rhomboidalis Meek, 1873, Paleontology of Ohio, i, 74.

Shell varying in outline, but generally subsemicircular, widest at the hinge-line; lateral and front margins bent strongly upward all around, the portion inclosed by the geniculated margin flattened in both valves; the surfaces of these flattened spaces marked by conspicuous concentric wrinkles that increase in size from the beak outward; area narrow in both valves, that of the ventral being a little wider than the other. Surface marked by fine radiating striæ, which are nearly uniform in size, close-set, increasing both by implantation and bifurcation, most frequently by the latter method on the ventral valve and by the former method on the dorsal. Under a lens, minute concentric striæ are usually to be seen, as is also the punctate structure of the test, upon exfoliated surfaces.

Breadth at the hinge-line, of the largest specimen contained in the collections, four and a half centimeters. They are often smaller than this, their proportions and outline being also very variable.

The geological range of this species is greater than that of any other

* This is one of the most widely known of all the species of fossil *Mollusca*, and by some of its varieties it is familiar to every geologist and collector. Mr. Davidson, in his well-known Monographs gives a large number of authorities who have written upon or noticed the species. The synonymy here given is selected for the purpose of indicating some of the principal points in its literary history and to show the numerous generic assignments that have been made of it besides the various specific names it has borne.

known fossil, which circumstance has naturally thrown much doubt on the real specific identity of specimens collected from rocks of different geological ages.

It appears under slight varietal forms in different formations, which, although not strongly marked, have served to induce some naturalists to separate them as distinct species; but after the scientific scrutiny these shells have had for more than a hundred years, no person has succeeded in pointing out characteristics which entirely satisfy naturalists that they really constitute more than one species. As thus specifically recognized, its range is from the Trenton period of Lower Silurian age to the Subcarboniferous period, and it is also a common fossil in both hemispheres. Therefore, whenever this species is found associated with Upper Silurian or Devonian forms, and more especially if found unassociated with other fossils, it has of itself no valuable significance as to the geological age of the strata in which it is discovered; but when found associated with true Carboniferous types, it is understood to indicate the Subcarboniferous age of the strata containing it, because that period is regarded as the extreme recent limit of the range of the species in time.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada, where it was found associated with the *Platycrinus* and *Actinocrinus* herein described as well as with other Subcarboniferous types.

FAMILY SPIRIFERIDÆ.

GENUS SPIRIFER Sowerby, 1815.

Spirifer centronatus Winchell.

Plate V, fig. 8 *a*, *b*, and *c*.

Spirifer centronata Winchell, 1865, Proc. Acad. Nat. Sci. Phila., 118.

Shell of medium size, usually subsemicircular in outline, broadest at the hinge-line; the cardinal extremities often cuspidate, but sometimes a little rounded; both valves moderately convex.

Dorsal valve broadly and regularly convex transversely, a little depressed at the lateral extremities; convexity abrupt along the median line from the beak to the middle of the valve, but from the middle to the front margin it is very slight or nearly straight; area very narrow; beak

strongly incurved and projecting a little over the hinge-line; mesial fold distinctly defined from the front margin to the apex of the beak, where it is minute, but widens a little more rapidly near the front than elsewhere; it is not much elevated above the adjacent parts of the valve, but is distinctly separated from them by an interspace on each side of it, which is a little deeper and wider than those which separate the plications from each other.

Ventral valve regularly arching from rear to front; sides somewhat regularly convex, but like the other valve it is a little depressed at the lateral extremities; beak prominent, strongly incurved, abruptly narrowing to a point; mesial sinus distinctly defined from the front border to the apex of the beak, nowhere very deep, increasing uniformly in width toward the front; area moderately narrow, striated transversely; foramen triangular, nearly equilateral.

Surface marked by from thirty-four to forty-two small, rounded, distinct plications, nearly or quite all of which are simple; the two plications that form the lateral boundaries of the mesial sinus a little larger than any of the others, gradually but slightly diminishing in size from the sinus to the lateral extremities, where they become obsolete. From four to six plications are found upon the mesial sinus and fold respectively, all of which are similar to those upon the sides of the shell, except that the former diminish more rapidly in width toward the beaks. Concentric lines and undulations exist upon both valves.

Breadth at the hinge-line, about thirty-eight millimeters; length from beak to front, twenty-two millimeters; thickness, sixteen millimeters.

Professor Winchell's type-specimens were obtained from the Subcarboniferous strata at Cuyahoga Falls, Ohio, and seem, from the description, to have consisted of ventral valves only. His carefully-drawn description of that portion of the shell agrees so very closely with the corresponding part of ours that I should entertain little or no doubt of the specific identity of the two if it were not that he speaks of his shell as being very nearly like *S. cuspidatus* Hall (not Martin), which I understand to differ considerably from ours.

Position and locality.—Subcarboniferous strata; Mountain Spring, old Mormon road, Nevada.

Spirifer striatus Martin, *sp.*Plate V, fig. 10 *a*.

Associated with characteristic Subcarboniferous forms at Mountain Spring, old Mormon road, Nevada, some specimens of the well and widely-known *Spirifer striatus* were obtained. They are all more or less imperfect, but their identity with that species seems unquestionable. The striæ which mark the surface are regular and nearly uniform in size, and show no inclination to become fasciculated as those of *S. cameratus* always do to a greater or less degree. The collections also contain specimens, apparently of this species, from a higher geological horizon, which are noticed upon another page, among the Coal-Measure species.

Varieties of *S. striatus* have been described under different specific names from the Subcarboniferous rocks of the United States; but when compared with authentic specimens from the Carboniferous rocks of Europe, I am not able to discover differences of specific value. In view of this fact, I have less hesitation in referring our specimens to *S. striatus* than I otherwise would have.

Spirifer extenuatus Hall.Plate V, fig. 9 *a*, *b*, *c*, and *d*.*Spirifer extenuatus* Hall, 1858, Geology of Iowa, i, pt. ii, 520.*Syringothyris Halli* Winchell, 1863, Proc. Acad. Nat. Sci. Phila., 8.

Shell of medium size, much extended at the hinge-line; length from hinge to front usually a little less than the height from the ventral beak to the dorsal umbo.

Ventral valve capacious, subpyramidal, having a moderately deep sinus, which is well defined from front to beak, and rapidly widening toward the front; beak extended, pointed, its point a little incurved over the area; sides sloping from the beak to the hinge-extremities with little or no convexity of outline, and also little or no convexity to the front and lateral margins; area large, triangular transversely striated, flat or distorted a little by the twisting of the beak, and its inclination more or less toward the dextral side of the shell; fissure of the area triangular, nearly twice as high as it is wide at the base; each of its lateral border-angles truncated by a shal-

low groove; a little more than one quarter of the length of the fissure from its apex closed by a slightly convex pseudo-deltidium.

Dorsal valve moderately convex, differing in degree of convexity in different directions from its middle, but is somewhat regular in all; front margin broadly and regularly rounded, except that the lateral extremities are more or less extended, and the central portion is emarginate by the infolding of the mesial sinus of the ventral valve; mesial fold moderately elevated, well defined from front margin to the beak, and increasing rapidly in width from beak to front.

Surface of both valves marked by from fourteen to eighteen rounded plications on each side of the mesial field and sinus, which become less distinct toward, and disappear upon, the lateral extremities; surface of both mesial fold and sinus plain, except that, in common with the surface of all other parts of the shell, it is marked by fine concentric lines of growth. Shell-substance distinctly punctate.

Breadth along the hinge-line, nearly four centimeters; height from ventral beak to dorsal umbo, eighteen millimeters; length from hinge to front margin, sixteen millimeters.

The transverse plate connecting the dental laminae, together with the tube, which it bears along the middle of its under surface (characters that distinguish the group of spiriferoid shells which Professor Winchell has separated under the generic name of *Syringothyris*), are concealed by the stony filling of our specimens; but as they possess the other characteristics of that group, those mentioned are doubtless present also. So far as external characters are concerned, no specific difference can be detected between our shell and *Syringothyris Halli* Winchell (*loc. cit.*). His type-specimens were obtained from strata of the Kinderhook formation at Burlington, Iowa, and Clarksville, Missouri. Those of Professor Hall were obtained from the same strata at the first-named locality. The want of material difference between the dorsal valve of Professor Hall's species (the only part of the shell described and figured by him) and the corresponding part of Professor Winchell's specimens, together with the fact that they are associated in the same strata at one of the typical localities, leaves little cause for doubting the specific identity of *Syringothyris Halli* and *Spirifer extenuatus*.

In the course of some extended remarks upon the genus *Spirifer*, Messrs. Meek and Worthen (Geological Survey of Illinois, vol. iii, 532) have shown that the original species of the genus possessed the same peculiarities of structure that formed the basis of Professor Winchell's genus *Syringothyris*. They also show that the numerous species which have been generally regarded as typical forms of the genus *Spirifer* really belong to a group for which Koenig proposed the generic name of *Trigonotreta* long before the publication of *Syringothyris*. This being the case, a strict enforcement of the rule of priority in scientific nomenclature will require that *Syringothyris* be suppressed, and that all shells having the structure which characterizes that group retain the name of *Spirifer*; also that Koenig's name *Trigonotreta* be applied exclusively to those ordinary forms which have so generally been referred to *Spirifer*, at least in a subgeneric sense. In view of the question thus raised, and being at present without the means of deciding it for myself by personal investigation, the generic assignments I have made of these forms in this report should be regarded as provisional only.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

SUBGENUS MARTINIA McCoy, 1844.

***Spirifer* (Martinia) peculiaris Shumard.**

Plate V, fig. 7 a and b.

Spirifer peculiaris Shumard, 1855, Geological Survey of Missouri, part 2, 202.

Ventral valve arching regularly from beak to front, the curvature being greatest near the beak; sides convex; beak narrow, extended, incurved; antero-lateral margins broadly rounded; postero-lateral margins abruptly rounded to the short hinge-line; postero-lateral surfaces rounded backward to the small, indistinctly-defined cardinal area; foramen triangular, its apical end closed by a pseudo-deltidium; mesial sinus shallow, traceable nearly to the beak, widening a little more rapidly near the front than elsewhere, nearly plain, but two faint, incipient plications are observable, one at each side, and also a slight flattening along its middle. Surface on each side of the sinus marked by six or seven small, convex-flattened plications, which are

separated by very narrow interspaces, becoming smaller toward, and finally disappearing upon, the postero-lateral regions.

Only the ventral valve of this species is contained in the collections; but that agrees in all essential characters with *S. peculiaris* Shumard, the type-specimens of which species were obtained from the Kinderhook formation of the Subcarboniferous group in Missouri. The principal variations which it shows from the typical forms as described and figured by Dr. Shumard are the incipient plications of the mesial sinus and the somewhat greater rounding of the postero-lateral angles. Possibly more perfect examples may show other differences also, but the characters so far observed do not seem to warrant a specific separation from *S. peculiaris*.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

GENUS SPIRIGERA D'Orbigny, 1847.

Spirigera monticola White.

Plate V, fig. 11, *a*, *b*, *c*, and *d*.

Spirigera monticola White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 16.

Shell subelliptical or subtetrahedral in outline, always wider than long, widest at, or a little forward of, the middle, moderately gibbous; valves almost equally capacious; postero-lateral margins in old shells thickened, but in younger ones the whole margin is more or less sharp; front margin only slightly sinuous in very young shells, but it is very deeply sinuous in some old ones.

Ventral valve broadly convex from side to side, regularly arching from beak to front; beak moderately prominent and slightly incurved; foramen, as usual, nearly round, rather small; mesial sinus moderately narrow, scarcely apparent in young shells, but in some old ones becoming very deep at the front, where the margin is much prolonged upward to follow the fold of the other valve.

Dorsal valve gibbous in the umbonal region, prominent along the middle, from which the sides slope away by gentle convexity to the lateral margins; mesial fold rather narrow, and in some examples not well defined,

in which case the valve has a broad, nearly uniform, convexity; yet in others the mesial fold is well defined and prominent, especially at the front; but in all cases it is hardly discernible behind the middle of the shell, even in adult examples.

Surface of both valves marked by concentric lines, of fine lamellæ of growth, and occasionally indications of fine radiating striæ are to be seen under a lens.

Length of an adult specimen of average size, twenty-three millimeters; extreme breadth, twenty-nine millimeters; height, sixteen millimeters.

This shell is quite different from any other described species of the genus known to occur in American Carboniferous strata. The most nearly allied form with which I am acquainted is an undescribed one in the Subcarboniferous strata of Franklin County, Iowa, with which our species is probably identical. It somewhat resembles *S. incrassatus* Hall from the Burlington limestone, but it differs from that species in outline, the less prominence of the ventral beak, the character of the mesial fold and sinus, and in the surface-markings.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

Spirigera obmaxima McChesney.

Plate V, fig. 12.

Athyris obmaxima McChesney, 1869, Descr. New Paleozoic Fossils, 80

Spirigera pectinifera Swallow, 1863, Trans. St. Louis Acad. Sci., ii, 88.

Shell large, broader than long, greatest breadth about midlength; outline suboval; ear-like projections of fibrous shell-substance sometimes seen upon the postero-lateral margins. Ventral valve broadly convex, bearing a broad, shallow mesial sinus upon the front half of old shells, obsolete upon the posterior half; greatest convexity at the umbonal region; beak not very prominent, incurved.

Dorsal valve having its greatest convexity along the median line; mesial fold indistinctly defined except at the front; umbonal region not prominent; beak strongly incurved beneath that of the other valve.

Breadth, six centimeters or more; length above five centimeters.

This species is remarkable for its great size, and, although the specimens of the collection are imperfect, I have hardly a doubt of their specific identity with *S. obmaxima* McChesney.

Position and locality.—Subcarboniferous strata; Mountain Spring, old Mormon road, Nevada, and also at a locality below Ophir City, Utah.

FAMILY TEREBRATULIDÆ.

GENUS TEREBRATULA Lhwyd, 1698.

SUBGENUS DIELASMA King, 1859.

***Terebratula* (*Dielasma*) *Burlingtonensis* White.**

Terebratula Burlingtonensis White, 1860, Jour. Bost. Soc. Nat. Hist., 228.

Shell of moderate size, subovate in outline, more or less gibbous, broadest a little forward of the middle.

Ventral valve regularly convex; beak prominent, projecting considerably behind that of the dorsal valve, moderately incurved; a faintly-defined ridge at each side of the beak follows its curvature from the foramen forward, and disappears near the middle of the shell; dental plates moderately strong, their front edges sharp and perpendicular with the teeth, placed near the sides of the beak, and diverging a little as the beak increases in size; mesial sinus absent or obsolete.

Dorsal valve depressed-convex, greatest convexity near the beak, which is not prominent; mesial fold absent. Surface smooth or marked by indistinct lines of growth; shell-structure finely punctate.

Average length, about twenty-two millimeters.

The type-specimens of this species were obtained from the Subcarboniferous rocks at Burlington, Iowa, and those of the collections agree with them in all essential respects. The reference to the subgenus *Dielasma* of this species is made in consequence of the presence of dental plates, the other characteristics of the subgenus not having been observed. It differs from *T. bovideus* especially in wanting the longitudinally arcuate form, so constant in that species.

Position and locality.—Strata of the Subcarboniferous period; Mountain Spring, old Mormon road, Nevada.

MOLLUSCA VERA.

CLASS CONCHIFERA.

ORDER DIMYARIA.

FAMILY CARDIIDÆ (?).

GENUS CONOCARDIUM Brown, 1835.

Conocardium ——— (?).

From strata of the Subcarboniferous period below Ophir City, Utah, a single example of a species of *Conocardium* was obtained. It is too imperfect for full specific determination, but its observable characters indicate that it belongs to an undescribed species. It is similar in size and also in many of its details to *C. trigonale* Hall from the Carboniferous limestone of New York and Ohio. The costæ and interspaces, as well as the very fine concentric striæ that mark the surface, are very similar to those of that species, but our shell differs in its smaller and more numerous costæ, in being less produced at the antero-ventral angle, and in the more distinct rounding of the antero-lateral ridges.

In case the discovery of more perfect specimens should confirm the opinion that this shell belongs to an undescribed species, I propose for it the name of *C. semiplenum*.

CLASS GASTEROPODA.

SUBCLASS DICECA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY EUOMPHALIDÆ.

GENUS EUOMPHALUS Sowerby, 1815.

Euomphalus luxus, White.Plate V, fig. 13 *a* and *b*.

Shell of medium size, subdiscoidal, the spire being only a little elevated; volutions four or five; outer side of volutions convex below but

flattened a little above so as to form a more or less distinct angle with the flattened upper side; under side regularly and continuously rounded from the outer side into the umbilicus, where it meets the next volution within; suture distinct; umbilicus moderately deep and broad. Surface marked by distinct lines and occasional corrugations of growth. Diameter of coil of the largest specimen in the collections, thirty-eight millimeters.

This species resembles *E. latus* Hall, the type-specimens of which were obtained from the Burlington limestone division of the Subcarboniferous group at Burlington, Iowa, and Quincy, Illinois. The specimens of the collection present differences from the typical forms of the species which I at first regarded as only varietal, but upon further examination I consider them specific; the principal of which differences are their smaller size, less rapidly increasing volutions, and the absence of the elevation, or incipient fold, upon the upper side of the volutions adjacent to the suture which characterizes *E. latus*.

Position and locality.—Strata of the Subcarboniferous period; below Ophir City, Utah, and also “near the base of the anticlinal”, at Ophir City.

CHAPTER VII.

CARBONIFEROUS PERIOD.

PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

GENUS FUSULINA Fischer, 1837.

Fusulina cylindrica Fischer.Plate VI, fig. 6 *a* and *b*.

- Fusulina cylindrica* Fischer, 1837, Oryct. du Gouv. de Moscou, 126.
Fusulina cylindrica D'Orbigny, 1845, Geol. Russ., ii, pt. iii, 16.
Fusulina cylindrica Owen, 1852, Geol. Surv. Wisconsin, Iowa, and Minnesota, 131
Fusulina cylindrica Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phila., 26.
Fusulina cylindrica Dana, 1862, Manual of Geology, 164.
Fusulina cylindrica Meek and Hayden, 1864, Paleontology Upper Missouri, 14.
Fusulina cylindrica Meek, 1864, Paleontology of California, pt. i, i, 4.
Fusulina cylindrica Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 71.
Fusulina cylindrica White, 1870, Geology of Iowa, i, 250.
Fusulina cylindrica Meek, 1872, United States Geol. Surv. of Nebraska, 140.

Shell varying from terete to subglobose, assuming all intermediate fusiform shapes, generally somewhat obtusely pointed, especially the terete ones, usually having the appearance of being slightly twisted at the ends; septal furrows moderately distinct, even upon unweathered specimens, extending in more or less direct lines longitudinally, but are a little deflected just at the ends; centrifugal apertures about twice as high as the thickness of the cell-wall covering them, more than twice as broad as high, and of nearly uniform size throughout the whole coil. The locular or external aperture, since it varied with the progress of construction of the cell, and

must have been fragile until it was completed, is seldom clearly shown upon the fossils.

It was apparently linear, extending the full length of the shell until closed by a new longitudinal septum at each side, leaving only a new centrifugal aperture at the middle, in line with the others. Volutions from five to eight; septa from twenty to thirty in the outer volution; septa nearly straight at their outer or external edges, but laterally undulating at their inner edges, where they join the outer surface of the next volution within, as may be seen in specimens that have had a part of their outer volution removed by weathering; the same defacement also showing portions of the series of centrifugal apertures. The undulations of the inner edges of contiguous septa are not usually parallel; but the convexity of the folds of each septum generally comes opposite that of the folds of the next adjacent septum, which gives rise to a peculiar confused and complex appearance of the septa in those specimens that have suffered erosion or weathering of the outer volution.

Dimensions very variable; one of the more robust specimens in the collections being one centimeter long and half a centimeter in diameter; another measures nine millimeters long and two millimeters in diameter.

Fischer described another species, together with *F. cylindrica* (*loc. cit.*), under the name of *F. depressa*, which latter species Dr. Geinitz (*loc. cit.*) recognizes from Upper Coal-Measure strata at Nebraska City, Nebraska. Meek and Hayden have proposed the name *F. ventricosa* to include certain robust forms from the Coal-Measures of Missouri and Kansas (Proc. Acad. Nat. Sci. Phila., 1858, 261), and Mr. Meek has described two other species from a similar horizon in California under the names of *F. robusta* and *F. gracilis* (Geological Survey of California, paleontology, vol. i, 1864). With due deference to the views of those able and careful paleontologists, I feel bound to differ with them in relation to the propriety of a specific separation of these forms. Long familiarity with this protean species, distributed over an extensive region, has served to convince me that all the varieties referred to, including *F. depressa* Fischer, belong to one species only. In Southwestern Iowa, where *Fusulina* is abundant in strata of the Upper Coal-Measures, varieties prevail at certain localities respectively that

will answer the description of every imputed specific form of the genus yet known to me. Intermediate forms may also be obtained in the same region that may be made to connect all the varieties referred to. Remembering also that these shells were formed by animals, each of which consisted of a mere particle of organless sarcode, not having even the least differentiation of tissue, the wonder seems rather that intra-specific variation should not be much greater than the difference is found to be between any individual shells hitherto referred to the genus *Fusulina*.

Position and locality.—Strata of the Carboniferous period at the following localities in Utah, besides others elsewhere: Wasatch range, south of Spanish Fork; U-i-ya-bi Pass, Gosute range; near Beckwith Spring, Cedar range; near the mouth of Spanish Fork Cañon; and southeast of Mount Nebo.

RADIATA.

CLASS ACTINOZOA.

ORDER ZOANTHARIA.

FAMILY FAVOSITIDÆ.

Genus CHÆTETES Fischer, 1837.

Chætetes milleporaceus Troost, *sp.*

Plate VI, fig. 2 *a*.

Calamapora milleporacea Troost, 1849? (manuscript).

Chætetes milleporaceus Edwards et Haime, 1851, *Monographie Polyp. Fossiles*, 272.

Polypary massive; cells slender, capilliform in aspect, of nearly equal size among themselves and of uniform diameter from their proximal to their distal ends; diameter of cells about one-third of a millimeter, and upon the split surfaces of some specimens they have been traced continuously nearly the length of a decimeter; masses varying in size from four or five centimeters to as many decimeters in diameter; shape of the masses irregularly globular to irregularly flattened-convex, the latter being the most usual form. Sometimes specimens, apparently of this species, are irregularly

elongate in form, and show some indications of incipient branching; but the species is essentially a massive and not a branching coral.

This coral is not uncommon in the Upper Coal-Measures of Missouri, Iowa, and Nebraska. The type-specimens of the species which were used by Edwards and Haime in their original description were obtained from Carboniferous strata in the Cumberland Mountains of Tennessee, and also from the same geological horizon near Evansville, Indiana. The late Dr. Troost had catalogued the species before his death, with the intention of publishing a description of it. In its subsequent publication by Edwards and Haime (*loc. cit.*), they adopted his specific name.

Position and locality.—Strata of the Carboniferous period; Virgin range, southwest of Saint George, Utah.

GENUS RHOMBIPORA Meek, 1872.

Rhombipora lepidodendroides Meek.

Plate VI, fig. 5 *a*, *b*, *c*, and *d*.

Rhombipora lepidodendroides Meek, 1872, United States Geol. Surv. Nebraska, 141.

Coral slender, ramose; stem and branches terete; branches not numerous, generally attaining at once nearly or quite the size of the stems: branching taking place at somewhat regular intervals in some specimens, but irregularly in others, the divergence being some thirty or forty degrees; stem and branches usually nearly or quite straight between the points of bifurcation, but neither the stem nor the branch above the point of bifurcation retain the axial direction of the part below; cells small; starting from a non-substantial axis they arch upward and outward, increasing a little in size as they extend, and open upon the outer surface; interspaces between the cells about equal in width to the diameter of the cells, the intercellular substance being itself minutely cellular in structure; cell-apertures rhombic or rhombic-oval in outline, the vertical diameter generally greatest; cells arranged in both vertical and oblique rows, which are always quite regular; spaces between the apertures ornamented with minute nodes, the largest ones of which are placed opposite the angles of the apertures, at which points there are sometimes two such nodes. Stems varying in diameter from one to four millimeters; number of cell-apertures five or six in the

space of two millimeters, measured parallel with the axis of the stem, and seven or eight in the same space measured along one of the oblique rows. The variation of the latter measurements in different specimens is not proportionally so great as the variation of the diameter of stems, because the angle of the oblique rows with the axis is greater in large stems than in small ones; this gives the cell-apertures a greater proportional width in large stems, while the actual width is nearly uniform in all.

Most of the examples in the collection are considerably larger than the type-specimens of Mr. Meek, but some of them agree perfectly with his types as to size, and the structure is identical in all, so far as can be determined. Specimens, apparently of this species, from the Upper Coal-Measures of Northern Missouri and Southern Iowa, are still larger than any contained in the collections. Some of the specimens of the collections are more or less completely silicified, and one or two of them have a hollow axis. This seems to have resulted from the failure of the central portion to become silicified like the outer portion, which, remaining calcareous, was subsequently removed by dissolving agencies that the outer silicified portion resisted. This is really shown to be the case by the breaking of others, and finding the central portion yet calcareous and retaining the structure of the coral, the parts of which structure being in direct continuity with those of the outer silicified portion. On the other hand, a fragment of a species of this genus obtained from the Subcarboniferous limestone of Washington County, Indiana, seems to have a hollow axis, the whole of the coral being calcareous. It is, however, not certain that the axis of even this example was originally hollow.

Position and locality.—Strata of the Carboniferous period; west face of Oquirrh range, near "E. T. City", Utah, and at the confluence of White Mountain and Black Rivers, Arizona.

GENUS SYRINGOPORA Goldfuss, 1826.

Syringopora multattenuata McChesney (?).

From strata of the Carboniferous period, at various localities in Nevada and Utah, specimens of a species of *Syringopora* were obtained. They are too imperfectly preserved for satisfactory specific identification,

but they probably belong to *S. mulattenuata* McChesney, as they are not unlike that species and occupy a similar geological position. That species is a more or less common one in the Upper Coal-Measure strata of Iowa, Illinois, Missouri, and Nebraska.

FAMILY CYATHOPHYLLIDÆ.

GENUS ZAPHRENTIS Rafinesque et Clifford.

Zaphrentis excentrica Meek.

Plate VI, fig. 3 *a*.

Zaphrentis excentrica Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 495.

Corallum large, comparatively short, broadly turbinate, slight curved; principal septa sixty or seventy, not extending to the center of the calyx, but leaving a large plain surface at its bottom; tabulæ numerous, broad, thin, transverse, or a little concave; vesicular zone comparatively narrow. Height, about seven centimeters; breadth at top, about six centimeters.

Our specimens are silicified and somewhat imperfect, but they are doubtless specifically identical with *Z. excentrica* Meek, the type-specimens of which were obtained from strata of the same period at "Old Baldy", near Virginia City, Montana.

Position and locality.—Strata of the Carboniferous period; Fossil Hill, White Pine County, Nevada.

GENUS LOPHOPHYLLUM Edwards et Haime, 1850.

Lophophyllum proliferum McChesney, *sp.*, var. *sauridens*.

Plate VI, fig. 4 *a*, *b*, *c*, and *d*.

Cyathaxonia prolifera McChesney, 1860, Descriptions of New Paleozoic Fossils, 75.

Cyathaxonia, *sp.*, Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 65-66.

Lophophyllum proliferum Meek, 1872, U. S. Geol. Surv. Nebraska, 144.

Corallum conical or elongate-conical, usually curved, rarely almost straight, tapering to a more or less slender point at its proximal end; transverse section circular; surface marked by longitudinal striæ of uniform size, some of which are continuous from the apex to the rim of the calyx, but the additional striæ required by the increasing diameter of the corallum are often so arranged as to form a kind of longitudinal suture by commencing successively along the side of an outer stria of a series that are continu-

ous from apex to calyx; longitudinal striæ crossed by more or less distinct wrinkles, and very fine encircling lines of growth.

Calyx comparatively deep; its sides rather thin between the septa, and of nearly uniform thickness from rim to bottom; rays within the calyces of the largest specimens sometimes reaching fifty in number, not projecting far inward from the sides except toward and at the bottom, upon which they reach the columella; bottom of the calyx really sloping downward from the columella all around, and ending abruptly against the sides, but the numerous septa, by gradually approaching the columella from the sides, give the bottom a concave appearance when viewed from above; septal fossette not very conspicuous, usually occupying a little more than the space of one principal body-ray, or septum; septa below the calyx, less numerous than the rays within it, well developed, and reaching nearly or quite to the columella, but none of them apparently becoming consolidated with it except the one opposite the septal fossette; columella strong, transverse section broadly oval, projecting considerably from the calyx, bluntly crested, well consolidated by the almost complete fusion of the middle portions of the tabulæ that compose it, not firmly united to the surrounding portions of the corallum, but readily cleaving from them when the parts are broken; when thus separated, its surface shows somewhat twisted, longitudinal, raised, striæ which correspond more or less closely with the inner edges of the septa, but are not really separated parts of them, as they at first sight appear to be; tabulæ comparatively thin, between the columella and the sides, sloping or arching downward, and ending abruptly against the inner side of the outer wall.

Length of the largest specimen in the collection, along its convex side, upward of four centimeters; diameter of the calyx, twelve millimeters. The average size of full-grown specimens is not materially less.

Our examples present a different aspect from typical forms of *S. proliferum*, and they perhaps belong to a different species; yet it is difficult to point out distinct structural differences of specific value. They have, however, a larger average size, and are more robust, less wrinkled, and less contorted than typical forms of *S. proliferum*, which characters seem to indicate at least a distinct variety, for which the name *sauridens* is proposed. The

prominent solid axis of that species, separating so readily from the surrounding parts in broken specimens, caused it for a time to be referred to the genus *Cyathaxonia*, but Mr. Meek has shown (*loc. cit.*) that it has the internal structure of *Lophophyllum*.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico, and at Rock Creek, Lake County, Colorado.

GENUS LITHOSTROTION Fleming, 1828

Lithostrotion Whitneyi Meek.

Plate VI, fig. 1 *a*, *b*, and *c*.

Lithostrotion Whitneyi Meek, 1875, Pal. of U. S. Geol. Expl. 40th Parallel, (manuscript).

Corallum fasciculated; corallites cylindrical, somewhat flexuous and irregular, generally separate but seldom distant, and sometimes in contact; epitheca thin but distinct, marked by wrinkles and encircling lines of growth; columella small and very narrow, being laterally compressed; principal rays from twenty to twenty-eight in number, according to the size of the polypite, alternating with smaller rays; tabulæ numerous, comparatively broad, transverse or arching downward from the columella; vesicular zone narrow, composed of from three to five layers of vesicles.

Diameter of polypites, from eight to fourteen millimeters.

In splitting and polishing a polypite, so as to obtain a view of the internal structure, it is often difficult to make the section in such a manner as to show the columella, because it is so small and narrow. If the section is made parallel with one of its flat sides, but not cutting through it, the tabulæ appear to be separate from each other in all parts, and to extend directly across the polypite, as in *Cyathophyllum*. Such a section is shown in figure 1 *c*, Plate VI. If the section passes obliquely through the columella, its character is indistinctly shown, as in figure 1 *b* of the same plate. The section given by Mr. Meek in his illustrations of the species is through the short diameter of the columella.

Position and locality.—Strata of the Carboniferous period; Fossil Hill and Ice Creek, Steptoe Valley, White Pine County, Nevada.

CLASS ECHINODERMATA.

ORDER ECHINOIDEA.

FAMILY ARCHÆOCIDARIDÆ.

GENUS ARCHÆOCIDARIS McCoy, 1844.

Archæocidaris ornatus Newberry.

Plate VI, fig. 7.

Archæocidaris ornatus Newberry, 1861, Geol. Rep. Lieut. Ives's Expl. Col. Riv., 116.

Principal spines fusiform, strong, about seven centimeters long; greatest diameter a little below the middle, where it is about five millimeters; surface for a short distance above the basal ring plain or not conspicuously marked; above this plain space to the distal end, it is thickly set with spinules from one to two millimeters in length, which are arranged around the spine in imperfectly spiral lines, in which lines the intervals between the spinules are generally less than the diameter of their bases, but the vertical intervals are somewhat greater; basal ring rather large, crenulated at the border. An imperfect interambulacral plate embedded in the rock near one of the spines contained in the collection, and probably belonging to this species, shows a plain areolar surface, a raised center, and an elevated rim around a rather small central tubercle. Remainder of the body unknown.

Dr. Newberry's type-specimens were obtained from strata of the Carboniferous period near the confluence of the two Colorados, and also from strata of the same period near the Great Cañon of the Colorado River.

Position and locality.—Strata of the Carboniferous period; ten miles west of Ojo del Oso, near Fort Wingate, New Mexico.

Archæocidaris tridifer White.Plate VI, fig. 8 *a* and *b*.

Archæocidaris tridifer White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 17.

Interambulacral plates comparatively broad, rather thin, having an elevated border all around, which is apparently composed of a series of small tubercles; areolar surface apparently plain; central tubercle small, perforate at the center, surrounded at its base by a very slightly-raised ring,

and immediately outside of that by another ring, which is so much elevated as to form a little cup, with its rim somewhat expanded. Diameter of the largest plate in the collection, about twenty millimeters.

Spines very long and slender, one of those in the collection having been, when perfect, about twelve centimeters in length, terete; diameter of the basal ring, which expands abruptly from the shaft, greater than that of any portion of the shaft; diameter of the shaft nearly uniform for more than half its length above the basal ring, the upper portion gradually tapering to a point. Greatest diameter of the shaft of the long spine referred to, scarcely five millimeters; diameter of the basal ring, seven millimeters. Surface of the spine for a short distance above the basal ring apparently smooth, but, from that portion to the distal end, it is ornamented with numerous small points or incipient spinules, which are often removed by weathering, but, in well-preserved specimens, they are seen to be arranged around the spine in imperfectly spiral lines.

The very long, slender, terete spine, having a basal ring often much greater in diameter than any part of the shaft, together with the other characters described, distinguish this species from all others.

Position and locality.—Strata of the Carboniferous period ("Red Wall limestone"); Camp Apache, Arizona.

MOLLUSCA.

MOLLUSOIDEA.

CLASS POLYZOA.

ORDER GYMNOŁÆMATA.

FAMILY MYRIAPORIDÆ.

GENUS GLAUCONOME Goldfuss, 1826.

Glaucanome nereidis White.

Plate VII, fig. 5 *a*, *b*, *c*, *d*, and *e*.

Glaucanome nereidis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 18.

Polyzoary branching, the main stem sending off branches at irregular intervals; these in like manner sending off secondary branches, but less

frequently; the stem and all the branches bearing branchlets of the usual character, in regular series at each side, all of which are straight or slightly curved; branches leaving the stem, and branchlets the stem and branches, at nearly or quite uniform angles of between sixty and seventy degrees; branchlets opposite, or alternating in their arrangement, the intervals between them being a little greater than the diameter of the branchlets; non-poriferous side of the stem, branches, and branchlets all convex and marked by fine longitudinal striæ. Poriferous side of the stem and branches bearing a row of pores along each of their lateral borders, the number of pores being about twice as great as that of the branchlets, but they are not placed in perfectly regular order with them. The space between these two lateral rows of pores is convex, and marked by scattered dimorphous pores that are not more than half as large as the principal ones which form the lateral rows. Branchlets also bearing a row of pores at each lateral border of the poriferous side, which are of the same character as the principal pores of the stem and branches, but they average a trifle smaller than those; pore-apertures with a rather prominent border, which gives the branchlets a somewhat knotted appearance under a lens.

There is considerable difference in the size of the broken stems and branches which constitute the specimens of the collection; but none of them, not even the longest fragment, perceptibly diminishes in size toward the distal end. The largest stem is about half a millimeter in diameter and the smallest not more than half that size. The branchlets vary from one to three millimeters in length. The whole extent of the branching of a polyzoary of this species is unknown; but, as the branches are only excessively developed branchlets, there seems to be no necessary restriction in this regard, but, in fact, the branching seems to have been somewhat limited. When one of the branchlets reached a little greater length than its fellows adjacent, it sent off branchlets from its own sides and became a branch. In a few cases, these first branchlets of the newly-formed branch have been seen to coalesce with adjacent branchlets of the stem, thus forming a few irregular fenestrules.

This species differs from *G. triliniata* Meek, from strata of the same period in Nebraska, in being much branched, and especially in the presence

of minute, dimorphous pores upon the axial portion of the poriferous side of the stem and branches, and also in the absence of the three longitudinal raised lines that distinguish that species.

Position and locality.—Strata of the Carboniferous period; at the confluence of White Mountain and Black Rivers, Arizona.

GENUS SYNOCLADIA King, 1849.

Synocladia biserialis Swallow.

Plate VII, fig. 3 *a*, *b*, and *c*.

Synocladia biserialis Swallow and Hawn, 1858, Trans. Acad. Sci. St. Louis. i, 179.

Synocladia virgulacea Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 70.

Synocladia biserialis Meek, 1872, U. S. Geol. Surv. Nebraska, 156.

Polyzoary probably infundibuliform, but the specimens usually found consist only of spreading frond-like fragments; primary branches a little larger than the others, the latter increasing by divergence at various angles from the primary branches, also occasionally from each other, and rarely by starting upward from the middle of a dissepiment; dissepiments celluliferous, a little narrower than the branches, and arching upward a little as they extend from branch to branch; fenestrules irregularly four-sided; upper side usually convex, and lower side sometimes concave, about nine in the length of a centimeter, measuring upward, generally wider than the branches, but occasionally narrower, especially near the base of the polyzoary. Upon the poriferous side, the branches and dissepiments, especially the former, are each provided with an irregular mesial carina, consisting of small, elongate, confluent nodes, which are sometimes sharp and prominent. Cell-apertures moderately large, rounded, borders prominent; cells arranged in single, quite distinct lines, one on each side of the mesial carina of the branches, and generally each dissepiment bears a double row of similar cells. Upon some of the dissepiments the cells form only a single row at the middle, while upon others they are not only double but another cell is added near the junction with the branch, giving three cells abreast at those points.

Professor Geinitz and others have referred this species to *S. virgulacea* as only varietally different from the typical forms of that species. *S.*

biserialis is now known to extend over an area more than one thousand miles across in a direct line, throughout the whole extent of which it is surprisingly constant in its specific characters, and just as constantly different from those of *S. virgulacea* as that species is represented by the figures and descriptions of European authors. The European species is without the mesial carina of ours, but has in its place a median row of pores, which our species never has.

Position and locality.—Strata of the Carboniferous period (Red Wall limestone); Camp Apache, Maricopa County, Arizona.

GENUS POLYPORA McCoy, 1844.

Polypora stragula White.

Plate VII, fig. 4 *a* and *b*.

Polypora biarmica Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 68 (not *P. biarmica* Keyserling).

Polypora (species undetermined) Meek, 1872, U. S. Geol. Surv. Nebraska, 155.

Polypora stragula White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 19.

Polyzoary apparently flabelliform; longitudinal branches bifurcating with more or less irregularity in different parts of the polyzoary; dissepiments little if any more than half as wide as the branches; fenestrules oval or oblong, the proportions of length and width varying in different parts of the polyzoary from about one-quarter longer than wide to twice as long as wide; varying also in size in different parts of the polyzoary, but averaging about six in number within the length of a centimeter, measured longitudinally; poriferous side of branches furnished with from four to six indistinct rows of small thick-set pores of uniform size, the arrangement of them in rows being more distinct obliquely than vertically; dissepiments usually free from pores, except near their junction with the branches, and a slightly-raised median ridge is often seen upon them.

This species is known to occur in the Carboniferous rocks of Iowa, Missouri, and Nebraska. It was from the latter State that Dr. Geinitz obtained the specimens which he referred (*loc. cit.*) to *P. biarmica* Keyserling, the type-specimens of which species were obtained from Permian strata of Petschoraland. Mr. Meek (*loc. cit.*) has pointed out very clearly the differ-

ence between our species and *P. biarmica*, and has also given for comparison a copy of Count Keyserling's figure, together with a copy of the figure of the species given by Dr. Geinitz.

Position and locality.—Strata of the Carboniferous period at the confluence of White Mountain and Black Rivers, Arizona.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY PRODUCTIDÆ.

GENUS *PRODUCTUS* Sowerby, 1812.

Productus costatus Sowerby(?).

Plate VIII, fig. 2 *a*, *b*, *c*, and *d*.

? *Producta costata* Sowerby, 1827, Min. Conch., vi, 115.

? *Producta costellata* McCoy, 1844, Synop. Carb. Foss. of Ireland, 108.

? *Productus costatus* de Verneuil, 1845, Geol. Russ. et. Ural Mts., ii, 268.

? *Productus costatus* de Koninck, 1847, Monog. Product., pl. viii, f. 3, and pl. x, f. 3.

Productus Portlockianus Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., viii, 15.

Productus costatus Shumard, 1855, Geological Report Missouri, 216.

Productus costatus var. Hall, 1858, Geology of Iowa, i, pt. 2, 712.

? *Productus costatus* Davidson, 1860, Monog. British Carb. Brachiopoda, 152.

? *Productus viminalis* White, 1862, Proc. Soc. Nat. Hist. Boston, ix, 29.

Productus costatus ? ? Meek, 1872, U. S. Geol. Surv. Nebraska, 159.

Shell of medium size; width greater than the length, measured in a straight line from hinge to front border, strongly and deeply arcuate; hinge-line nearly or quite equal in length to the greatest width of the shell; ears thin, well defined, and bent slightly downward; free margin broadly rounded, front emarginate.

Ventral valve very gibbous and strongly curved, having a broad shallow sinus extending from the umbonal region to the front, producing there the before-mentioned emargination of the front border; beak prominent, incurved, but only very slightly projecting over the hinge-line.

Dorsal valve flattened or only slightly concave in the visceral region, abruptly curved upward at the lateral and front margins; front showing a very slight mesial fold, corresponding with the broad, shallow mesial sinus of the other valve.

Surface of both valves, except that of the ears, marked by distinct, more or less unequal, rounded, radiating costæ, with interspaces of somewhat less than their own width between them; costæ generally continuous through a greater part of the length of the shell, but sometimes bifurcating, and occasionally two or more of them may be seen to coalesce and form a single costa of more than ordinary size; crossing the costæ, especially on the posterior half of the shell, and forming indistinct reticulations with them, are concentric wrinkles, more or less numerous. Upon the ventral valve, especially toward the margins, and upon the ears, there are usually scattered strong, more or less perpendicular, spines; some shells are apparently nearly free from spines, or have only a few of them upon and near the ears.

This shell is the American representative of the European *P. costatus* Sowerby, and has been, by European and most American geologists, referred to that species, in the belief that the differences are at most only varietal. Mr. Meek has, however, shown, in his paleontological report for the United States Geological Survey of Nebraska, that there are good reasons for doubting the specific identity of the American with the European shell. If his conclusions are correct, as they are believed to be, the proper name of this shell is *P. Portlockianus* Norwood and Pratten, these authors having been the first to recognize and publish the American form as distinct from the European. This species as it occurs in American strata is not only a variable one, but some of the varieties show so much constancy that they seem almost worthy of specific separation from the typical forms. One of these varieties was found plentifully near Santa Fé, New Mexico; but the figures given upon Plate VIII are of such examples as are regarded as typical forms of the species as it occurs in American strata. In *P. viminalis* White, from the Burlington limestone (Subcarboniferous), the front is more than usually produced, the costæ prominent, and more or less fasciculated, but these differences are probably only varietal.

The geological range of this species is through the strata of the whole Carboniferous period in Illinois, Missouri, Iowa, and Nebraska; and if *P. viminalis* is only a variety, as it is now supposed to be, the range is far toward the base of the Subcarboniferous group also.

Position and locality.—This is one of the most abundant species in the

collections, it having been found at almost every locality at which collections were made from strata of the Carboniferous period. It occurs at the following, among other localities:—Camp Cottonwood, old Mormon road, Lincoln County; top of Grass Mountain, Ely range, thirty-five miles north of Pioche; and at Silver Peak, Nevada: head of Partridge Creek, Yavapai County; Salt River; and head of Big Dry Fork, Arizona; Kanab Cañon, Arizona: Rock Cañon, Wahsatch range, near Provo; Lake range, Fairfield road, and first camp south of Saint George, Utah; near Bear Spring; Camp Wingate, and in the Zuñi Mountains, between Camp Wingate and Nutria Spring, New Mexico.

Productus semireticulatus Martin, *sp.*

Plate VIII, fig. 1 *a*, *b*, and *c*.

- Anomites semireticulatus* Martin, 1809, *Petrificata* Derb., 7.
Anomites productus Martin, 1809, *Petrificata* Derb., 9.
Productus scoticus Sowerby, 1814, *Min. Conch.*, i, pl. lxix, f. 3.
Productus antiquatus Sowerby, 1814, *Min. Conch.*, i, 15.
Producta Martini Phillips, 1836, *Geology of Yorkshire*, ii, 213.
Producta pugilis Phillips, 1836, *Geology of Yorkshire*, ii, 215.
Leptaena antiquata Fischer, 1837, *Oryct. du Gouv. de Mosc.*, pl. xxvi, figs. 4–5.
Leptaena tubifer Fischer, 1837, *ib.*, pl. xxvi, f. 1 (not Deshayes).
Productus Inca D'Orbigny, 1843, *Paleont. Voyage dans l'Amér. Mérid.*, viii, 51.
Producta flexistria McCoy, 1844, *Synop. Carb. Fossils of Ireland*, 109.
Productus semireticulatus de Koninck, 1847, *Monog. Gen. Product.*, pl. viii, f. 1.
Productus semireticulatus Shumard, 1855, *Geological Report of Missouri*, 216.
Productus semireticulatus Davidson, 1857, *Monograph British Carb. Brach.*
Productus semireticulatus Marcou, 1858, *Geology of North America*, 46.
Productus semireticulatus Hall, 1858, *Geology of Iowa*, i, pt. 2, 637.
Productus Calhounianus Swallow, 1858, *Trans. Acad. Sci. St. Louis*, i, 181.
? *Productus Ivesii* Newberry, 1861, *Expl. Exp. Col. Riv.*, *Paleont.*, 122.
Productus semireticulatus Meek, 1872, *U. S. Geol. Surv. Nebraska*, 160.

Shell large, very arcuate; width greater than the length, the latter being measured in a straight line from hinge to front; length of hinge-line sometimes less and sometimes greater than the greatest width of the shell in front of it; area of both valves distinct, but, as usual in this genus, very narrow; ears thin, more or less prominent; lateral and front borders rounded; front emarginate.

Ventral valve very strongly curved; beak depressed and projecting a little or not at all over the cardinal border; a broad, shallow, obscurely

defined mesial sinus extends from near the umbonal region to the front, giving the shell an indistinctly-bilobed appearance. Dorsal valve flattened in the visceral region, bent abruptly upward at the sides and front; beak flattened or slightly concave.

Surface of both valves marked by numerous coarse, rounded striæ, or small costæ, which are crossed in the visceral region by somewhat regular concentric wrinkles of nearly uniform size, giving that part of the shell a semireticulated appearance, which is more distinct in some examples than in others; more or less numerous, strong, erect spines are scattered upon the ventral valve, generally arising from the costæ upon the body of the shell, and from the strong wrinkles upon the ears, upon which latter part they are usually most numerous.

Length of a full average-sized specimen, measured in a straight line from hinge to front, four and a half centimeters; width, six centimeters.

The foregoing synonymy, copied largely from the works of Davidson and Meek, shows that this shell presents such variations, both in America and Europe, that it has been described under a variety of specific names by paleontologists of both hemispheres. The differences between the varieties thus described under different specific names are, in some cases at least, really very great; but, so far as my own observation has extended, there is such a want of constancy in these varieties, and such a lack of definite specific characters by which they may be clearly separated, that I am disposed to refer them all to one species, with the possible exception of *P. Ivesi* Newberry.

Viewing the species in this light, it is one of the most remarkable of all known fossil shells, not only for its great variation, but for its wide geographical distribution and great geological range. It is now known as a common fossil in the Carboniferous strata of Europe, India, South America, and North America. It is found in the Keokuk limestone of the Sub-carboniferous period, in Illinois, Iowa, and Missouri, and also ranges through the whole series of strata of the Carboniferous period of those States as well as in Kansas and Nebraska. The localities given below make a still further addition to its known geographical range; but most of the examples in the collections are of the variety *P. Ivesi*.

Position and locality.—Strata of the Carboniferous period:—near Bear Spring, Camp Wingate, and near Santa Fé, New Mexico: Camp Cottonwood, old Mormon road, Lincoln County, and top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada: head of Partridge Creek; near Bill Williams's Mountain; Tenney's Ranch; Kaibab Plateau; head of Dry Fork, and Kanab Cañon (Aubrey limestone), Arizona: crest of Hurricane Hill, near Toquerville, and Meadow Creek, south of Fillmore, Utah.

Productus Prattenianus Norwood.

Plate VII, fig. 1 *a*, *b*, and *c*.

- Productus cora* Owen, 1852, Geol. Report Iowa, Wisconsin, and Minnesota, pl. v, fig. 1 (not d'Orbigny).
Productus semireticulatus Hall, 1852, Stansbury's Report Great Salt Lake, 411 (not Martin, *sp.*).
Productus Prattenianus Norwood, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 17.
Productus æquicostatus Shumard, 1855, Geol. Report Missouri, 201.
Productus cora Marcou, 1858, Geology of North America, pl. vi, figs. 4 and 4^a (not d'Orbigny).
 ? *Productus lævicostus* White, 1860, Jour. Bost. Soc. Nat. Hist., vii, 230.
Productus Flemingii Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 52 (not Sowerby, 1814).
Productus Calhounianus Geinitz, 1866, *ib.*, 81 (not Swallow, 1858).
Productus Koninckianus Geinitz, 1866, *ib.*, 53 (not de Verneuil, 1845).
Productus Prattenianus Meek, 1872, U. S. Geol. Surv. Nebraska, 163.

Shell usually of medium size, but sometimes quite large; breadth generally greater than the length, if the latter be measured in a straight line from hinge to front; hinge in most cases longer than the greatest width of the body of the shell; lateral and front margins regularly and continuously rounded; ears prominent, thin, and generally broken off in the embedding rock; mesial fold and sinus wanting.

Ventral valve somewhat uniformly convex, but in some old shells there is a greater or less mesial flattening of the visceral region; umbonal region gibbous as a rule, but in rare cases depressed; beak hardly projecting over the cardinal border; ears marked by strong wrinkles, which are continuous with similar faint ones that pass up from each side toward the visceral region of the valve, and in rare cases meeting at the middle, the wrinkles ending posteriorly at the cardinal margin, upon which they produce an appearance similar to that of a curtain gathered upon a cord.

Surface of the valve marked by fine, regular, rounded striæ, some of which may be traced continuously from the umbonal region to the front, increasing by implantation, and occasionally coalescing; somewhat strong, erect spines are usually scattered over the surface, the cardinal border being furnished with numerous strong ones, pointing backward.

Dorsal valve somewhat uniformly concave; ears with folds or wrinkles corresponding with those of the other valve; surface marked like that of the ventral valve, except that it is without spines and concentric folds, and that the lines of growth are rather more distinct upon it.

Length of a very large specimen, six centimeters; breadth, six and a half centimeters; but the average size is about one-third less.

This species ranges through the whole Coal-Measure or Carboniferous series; and if, as now seems probable, *P. lævicostus* White, from the Kinderhook formation in Iowa, is not specifically different, its range is through all the strata of both the Subcarboniferous and Carboniferous periods.

Position and locality.—Strata of the Carboniferous period:—near Santa Fé and Zandia Mountains, New Mexico: Piloncillo range near Gavilan Peak, and at the confluence of White Mountain and Black Rivers, Arizona: Egan range, thirty-five miles south of Egan Pass; Fossil Hill, White Pine County; Roberts' Creek range, Lander County; and top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada: near Beckwith Spring, Cedar range; near the top of Mount Nebo; and upon the west face of Oquirrh range, Utah. Imperfect specimens, apparently belonging to this species, were also found at Mountain Spring, Lincoln County, Nevada, and at a locality below Ophir City, Utah, in rocks that I have referred to the Subcarboniferous period. As already shown, it is not improbable that the species ranges from strata of that period upward.

Productus punctatus Martin, *sp.*

Plate VII, fig. 2 *a*, *b*, and *c*.

Anomites punctatus Martin, 1809, *Petrificata* Derb., pl. xxxvii, fig. 6 (only).

Trigonia rugosa Parkinson, 1811, *Organic Remains*, iii, pl. xii, fig. 11.

Productus punctatus Sowerby, 1822, *Min. Conch.*, 22.

Anomites thecarius Schlotheim, 1823, *Nachtrag zum Petref.*, ii, 63.

Productus concentricus Potiez et Michaud, 1844, *Gal. des Moll. du Mus. de Donai*, ii, 25.

Producta punctata Phillips, 1836, *Geology of Yorkshire*, 215.

- Leptaena sulcata* Fischer, 1837, Oryct. du Gouv. de Moscou, pl. xxiii, fig. 2 (not Sowerby).
Productus semipunctatus Shephard, 1838, Amer. Jour Sci., xxxiv, fig. 9.
Productus punctatus de Koninck, 1843, Animaux Foss. Carb. Belg., 196.
Productus punctatus de Verneuil, 1845, Russia and the Ural Mountains, ii, 276.
Productus vittatus Hall, 1858, Geology of Iowa, i, pt. ii, 639.
Productus punctatus Davidson, 1860, Monog. British Carb. Brachiopoda, 172.
Productus tubulospinus McChesney, 1860, Deser. New Paleozoic Fossils, 37.
Productus punctatus Meek, 1872, U. S. Geol. Surv. Nebraska.

Shell large, thin; outline varying from imperfectly four-sided, the narrowest side being the posterior one, to subovate; sometimes wider than long, but oftener longer than wide; cardinal margin almost invariably shorter than the width of the shell at any part in front of it; anterior border broadly rounded, but usually a little emarginate at the middle; sides flattened, by which means the lateral margins are somewhat straightened; ears small.

Ventral valve broadly arcuate from front to rear, in which direction there is also a broad mesial flattening of the valve, with usually a shallow but distinct mesial sinus along its middle; umbo prominent, narrow, beak small, incurved, and projecting slightly over the cardinal margin. Dorsal valve moderately concave; beak concave; mesial fold slightly raised, extending along the visceral and anterior portions of the valve.

Surface of both valves marked by rather numerous and regular concentric folds, which are smaller at the beak and borders than elsewhere upon adult shells, and smaller and more indistinct upon the dorsal than upon the ventral valve; interspaces between the concentric folds plain; folds supporting numerous spines of various sizes, but all small, and all more or less appressed.

Length of the specimen figured, four and a half centimeters; breadth, at the broadest part, four centimeters; but this is rather smaller than the average size of adult shells.

This species is known throughout the whole Coal-Measure series of the United States, especially in the valleys of the Mississippi and Missouri, and is also a common Carboniferous species in Europe. Besides its range through all the strata of the Carboniferous period in this country, examples are frequently found in the Subcarboniferous strata of Missouri, Illinois,

and Iowa that I am quite unable to separate specifically from *P. punctatus*, among which are the examples described by Hall (*loc. cit.*) under that name, from the Keokuk limestone at Keokuk, Iowa, and Nauvoo, Illinois. The collections contain comparatively few specimens of this species, a fact probably due less to its scarcity or absence at other localities than to the well-known fragility of the shell, which has doubtless prevented its perfect preservation, such as we find in the case of many other shells associated with it.

Position and locality.—Strata of the Carboniferous period; at and near the top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada.

***Productus Nebrascensis* Owen.**

Plate VIII, fig. 3 *a*, *b*, *c*, and *d*.

Productus Nebrascensis Owen, 1852, Geol. Report Iowa, Wisconsin, and Minnesota, 584.

Productus Rogersi Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 9.

Productus Rogersi Hall, 1856, Pacific Railroad Report, iii, 104.

Productus asper McChesney, 1860, Descr. New Paleozoic Fossils, 34.

Strophalosia horrescens Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 81 (not Murchison, de Verneuil, and Keyserling, 1845).

Productus Nebrascensis Meek, 1872, U. S. Geol. Surv. Nebraska, 165.

Shell of about average size for a species of this genus; outline, in front of the cardinal border, suboval or sub-hemispherical; length usually less than the breadth; hinge generally less in length than the greatest breadth of the shell, and seldom equaling it; antero-lateral margins strongly, and front margin broadly, rounded, the latter sometimes a little emarginate; postero-lateral margins somewhat straightened upon, and in front of, the ears, meeting the cardinal border at a somewhat obtuse angle; ears small, seldom prominent.

Ventral valve somewhat regularly convex from front to rear; greatest convexity behind the middle; umbo prominent, projecting behind the hinge-line; beak prominent, incurved a little over the cardinal margin; a mesial flattening, amounting sometimes, but rarely, to a distinct sinus, extending from the umbo to the front margin. Dorsal valve flattened in the visceral region, the antero-lateral and front portions curving abruptly upward; beak

and auricular regions depressed so as to produce a slightly-raised, rounded, diverging fold between them, respectively, at each side; mesial fold seldom distinct, and perceptible only at the front.

Surface of both valves covered with numerous spines of different sizes, but all very small; those of the ventral valve are borne upon more or less distinctly defined concentric folds, and may be divided into two sets, or kinds, one consisting of the stronger and more erect spines, and the other of small, short ones, which latter are closely appressed against the surface; both kinds are more or less connected by means of numerous raised, radiating lines, which are apparent upon the concentric folds, but scarcely so upon the surface of the interspaces.

Length, thirty-three millimeters; breadth, thirty-five millimeters.

As usually obtained from a limestone matrix, the spines and more or less of the surface of the shell remain with the matrix. Such specimens present an appearance so different from that of those which have been perfectly preserved in a soft matrix that they have been referred to different species. Among references of this kind is that made by Professor Geinitz (*loc. cit.*) of this species to *Strophalosia horrescens*. Concerning this I can only say that I have collected and examined hundreds of examples of this species from his typical locality, and from numerous other localities in Nebraska, Iowa, Illinois, and Missouri, many of them having the interior and all other parts well preserved and shown, and not one of them was found to possess any of the generic characters peculiar to *Strophalosia*. That, as suggested by Dr. Geinitz, the genus *Strophalosia* may have been developed from *Productus*, and also that in some cases, while it was effecting such a generic transition, the specific characters may have remained comparatively unchanged, I am willing to believe; but that question need not be now discussed. That *Productus Nebrascensis*, however, affords any evidence of such a change, I am by no means prepared to admit.

Position and locality.—Strata of the Carboniferous period:—Camp Apache and Carrizo Creek, Maricopa County, Arizona: Rubyville, Schell Creek range; and top of Grass Mountain, Ely range, Nevada: Meadow Creek, south of Fillmore, Utah; and other localities.

Productus longispinus Sowerby.Plate VIII, fig. 5 *a*, *b*, *c*, and *d*.*Productus longispinus* Sowerby, 1814, Mineral Conchology, i, 154.*Productus Flemingii* Sowerby, 1814, ib., 154.*Productus spinosus* Sowerby, 1814, ib., 155.*Productus lobatus* Sowerby, 1814, ib., iv, 16.*Producta setosa* Phillips, 1836, Geol. of Yorkshire, ii, 214.*Productus longispinus* de Koninck, 1843, Anim. Foss. Terr. Carb. Belg., 184.*Productus capacii* d'Orbigny, 1843, Voyage dans l'Amérique Mérid., iii, 50.*Productus tubarius* Keyserling, 1846, Reise in das Petschora Land, 208.*Productus longispinus* Davidson, 1853, Int. Brit. Foss. Brach., pl. ix, 221.*Productus Wabashensis* Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 13.*Productus splendens* Norwood and Pratten, 1854, ib., 11.*Productus Orbignyanus* Geinitz, 1866, Carbonformat. und Dyas in Neb., 56 (not de Koninck, 1848).*Productus horridus* Geinitz, 1866, ib., 55 (not Sowerby, 1822).*Productus longispinus* Meek, 1872, U. S. Geol. Surv. Nebraska, 161.

Shell small, almost always broader than long, usually broadest at the hinge-line; ears distinct, a little reflexed, sometimes very prominent, each antero-lateral border regularly rounded from the base of the ear to the mesial sinus.

Ventral valve very gibbous, greatest convexity behind the middle, where the antero-posterior curvature is sometimes so abrupt as to make the hinder portion almost perpendicular with the plane of the margins, but the curvature is generally more regular, carrying the umbonal region to the rear of the hinge-line; beak small, slightly prominent, barely projecting over the cardinal margin; mesial sinus usually broad and distinct, but sometimes almost obsolete; postero-lateral slopes almost perpendicular with the ears. Surface of the valve marked by fine, radiating, rounded striæ, which are variable in their distinctness and size in different shells as they are also in different varieties, more distinct on the ventral than on the dorsal valve, generally obsolete on the umbonal region of both valves; striæ crossed by fine concentric wrinkles, which are distinct in some specimens but obsolete in others; fine concentric lines of growth are also to be seen under a lens; spines strong, erect, long, scattered over the surface somewhat uniformly, but from

some specimens they have been removed so completely that they appear as if they had borne none.

Dorsal valve concave, having a faint mesial fold in front corresponding with the sinus of the other valve. No spines have been observed on the dorsal valve; but in other respects its surface is marked like that of the other.

Length of a large specimen from Meadow Creek, Utah, eighteen millimeters; length of a specimen of a variety obtained from near Santa Fé, New Mexico, twelve millimeters; breadth of the one last mentioned, thirteen millimeters.

The fact that Sowerby, who first described this species, divided it up into four, and that Phillips and Keyserling each added another one, is sufficient to indicate its variable character in Europe. The American forms are now almost universally regarded as identical with the European, and it is an interesting and significant fact that the species is as variable in this part of the world as its European representative is. Some of the American varieties are quite constant. The collections contain several fine examples, of one of these varieties from near Santa Fé, New Mexico, which variety is as worthy of a separate specific designation as any of those that have been mentioned. This variety is represented by figures 5 *c* and *d*, Plate VIII. It uniformly smaller than the average size of typical examples; the mesial sinus is obsolete, spines delicate, and the surface upon the visceral region more or less distinctly wrinkled.

Taking the view of the identity of this species that is indicated by the foregoing remarks, and the synonymy herewith presented, its geographical and geological range is found to be very great. It is a well-known fossil in the Carboniferous rocks of Europe, and also those of both North and South America. In this country, it is found to range through the whole series of strata of the Carboniferous period; but, so far as I am aware, it has not thus far been found in the Subcarboniferous rocks of North America.

Position and locality.—Strata of the Carboniferous period; east of Minersville, and at Meadow Creek, south of Fillmore, Utah; Camp Cottonwood, old Mormon road, Lincoln County, Nevada; near Santa Fé, New Mexico.

Productus muricatus Norwood and Pratten.Plate VIII, fig. 4 *a*, *b*, and *c*.*Productus muricatus* Norwood and Pratten, 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 14.

Among the collections made by Prof. J. J. Stevenson from the "Middle Division, Carboniferous, Rock Creek, Lake County, Colorado", are some imperfect but unmistakable specimens of *P. muricatus* Norwood and Pratten. This is quite a well-known form; but Mr. Meek (U. S. Geological Survey of Nebraska, page 161) refers it with doubt to *P. longispinus*. Having found, in a long familiarity with all these shells, that, unlike most of the admitted varieties of *P. longispinus*, this species retains its specific characteristics with great constancy over wide areas, I am disposed to regard it as a distinct species.

So far as at present known, the geological range of the species is through the whole of the Carboniferous or Coal-Measure series. In Iowa, I found it almost characteristic of the Middle Coal-Measures, in the limestones and calcareous shales of which it was often found abundant.

Productus Mexicanus Shumard (?).Plate VIII, fig. 6 *a*, *b*, and *c*.*Productus Mexicanus* Shumard, 1858, Trans. Acad. Sci. St. Louis, i, 291.

Shell small, usually wider than long, emarginate in front, and flattened a little at the sides, giving it a somewhat four-sided outline when viewed vertically; cardinal border equal to, or greater than, the greatest breadth of the body of the shell; ears more or less prominent, distinctly defined and convex upon the ventral side. Ventral valve strongly and somewhat regularly arched, the curvature being greatest posteriorly; beak somewhat prominent, and slightly incurved over the cardinal border; mesial sinus obsolete or indistinctly defined, and disappearing at the visceral region.

Surface marked by from sixteen to twenty rounded, radiating costæ, with interspaces of similar width, all of which are most distinct upon the front part of the shell; the visceral region marked by concentric wrinkles, and the whole surface by fine concentric lines of growth; strong erect spines are scattered over the surface of the ventral valve, borne upon the costæ. Dorsal valve unknown.

Length, fourteen millimeters; breadth, in front of the ears, fifteen millimeters.

This shell differs considerably from any *Productus* known to me in the Carboniferous strata, and especially from any of its size, in the proportionally large size of its costæ. It answers the description given by Dr. Shumard (*loc. cit.*) in almost all particulars; but, as he gave no figure, I am a little in doubt as to its identity. Dr. Shumard described the species from what he then regarded as Permian strata of the Guadalupe Mountains, New Mexico, but they are perhaps equivalent with those now generally regarded as belonging to the Carboniferous period.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, old Mormon road, Lincoln County, Nevada, and also near Salt lake, New Mexico.

GENUS CHONETES Fischer, 1837.

Chonetes platynota White.

Plate IX, fig. 6 *a*, *b*, *c*, *d*, and *e*.

Chonetes platynota White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 19.

Shell rather under average size, transversely suboval or indistinctly four-sided; length of hinge-line usually about equal to the greatest width of the shell, but it is sometimes a trifle greater and sometimes a trifle less.

Ventral valve moderately convex, flattened a little toward the hinge-extremities, without a defined mesial sinus, but in place of it there is a mesial flattening or a slight bending upward at the front, which straightens or emarginates the front border a little; beak not prominent; area of moderate width, wider than that of the other valve, bearing on its posterior margin five or six rather small oblique tube-spines each side of the beak. Dorsal valve almost flat, as often a little convex as concave, especially from side to side; mesial fold represented only in adult shells, and in these only by a very slight elevation of the front margin following the slight flexure of the margin of the ventral valve.

Surface of both valves marked by numerous fine, rather obscure, radiating striæ, and occasional imbricating lines of growth.

Length, nine millimeters; breadth, twelve millimeters.

There are only three species yet published from strata equivalent with those which contain this species that are likely in any degree to be confounded with it. From *C. glabra* Geinitz, which it resembles in size and outline, it differs in being radiately striated instead of smooth, in wanting a proper mesial fold and sinus, and in having a flat or slightly convex, instead of concave, dorsal valve. From *C. Verneuillianus* Norwood and Pratten, it differs in being much less extended at the hinge-line, in wanting a proper mesial fold and sinus, and in its flat or convex, instead of concave, dorsal valve. From *C. granulifera* Owen, it differs in its flat or slightly convex dorsal valve, its less extended hinge, and in its much smaller size and different outline.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, and near Salt Lake, New Mexico.

***Chonetes granulifera* Owen.**

Plate IX, fig. 8 *a*, *b*, and *c*.

Chonetes granulifera Owen, 1855, Geol. Report Min., Iowa, and Wisconsin, 583.

Chonetes mucronata Meek and Hayden, 1858, Proc. Acad. Nat. Sci. Phila., 262.

Chonetes mucronata Meek and Hayden, 1864, Paleont. Upper Missouri, 22.

Chonetes mucronata Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 60.

Chonetes granulifera Meek, 1872, U. S. Geol. Surv. Nebraska, 170.

Shell rather large, somewhat semicircular in outline, but the ears are often extended, and the front a little emarginate. Ventral valve having a broad general convexity, which is most prominent at the visceral region on each side of a broad, shallow mesial sinus; postero-lateral portions compressed; beak small, not prominent; cardinal margin having from six to ten oblique tube-spines on each side of the beak; area narrow; foramen broad, and partially closed by a convex pseudo-deltidium; dorsal valve more or less concave, greatest concavity at the beak and central portion; ears flattened; area well developed, narrow; the cardinal process occupying the unclosed portion of the foramen of the other valve.

Surface of both valves marked by very fine, somewhat indistinct, radiating striæ, which are crossed by a few concentric lines of growth. The hinge-line of the largest examples sometimes reaches a length of nearly three centimeters, and the shell a length of sixteen millimeters.

This species is quite a common one in the Upper Coal-Measures near

the Missouri River in Missouri, Iowa, and Nebraska, and is represented lower in the Carboniferous series in the two first-named States and in Illinois by shells of somewhat smaller size, but otherwise apparently identical in species. It is probable also that this last-named variety is identical with *C. Smithii* Norwood and Pratten, and if so it becomes another synonym of *C. granulifera*.

Position and locality.—Strata of the Carboniferous period (Upper Aubrey limestone); Kanab Cañon, Arizona.

***Chonetes mesoloba* Norwood and Pratten.**

Plate IX, fig. 7 a.

Chonetes mesoloba Norwood and Pratten? 1854, Jour. Acad. Nat. Sci. Phila., n. s., iii, 27.

Shell rather small, transverse, somewhat distinctly quadrilateral, seldom wider at the hinge than it is in front of it. Ventral valve having a greater or less general convexity; mesial sinus comparatively large, and bearing along its middle a small mesial fold or lobe; between the sinus and the postero-lateral portions of the valve there is at each side a comparatively large, more or less prominent, rounded fold, extending from near the beak to the antero-lateral margin. Dorsal valve concave, having at the front two folds, with a mesial depression between them, the depression corresponding with the mesial lobe within the sinus of the ventral valve. Surface marked by fine radiating striæ.

Length of the specimen figured, six millimeters; breadth, nine millimeters; but examples are often found that are one-third larger than this.

The constant presence of a lobe or fold in the mesial sinus of the ventral valve of this shell clearly distinguishes it from all other known species of the genus. Its range is through the whole series of strata of the Carboniferous period in Illinois, Missouri, and Iowa. In the latter State, it has been found almost wholly confined to the Middle Coal-Measures.

Position and locality.—The collections contain only a single specimen of this interesting species, which was obtained from strata of the Carboniferous period, at the confluence of White Mountain and Black Rivers, Arizona.

FAMILY STROPHOMENIDÆ.

GENUS HEMIPRONITES Pander, 1830.

Hemipronites crinistria Phillips, *sp.*Plate X, fig. 9 *a.*

One of the most common fossils found in the rocks of the Carboniferous period in Illinois, Missouri, Iowa, Nebraska, and Kansas is a very variable shell that has during the past few years been generally referred to *Hemipronites crassus* Meek and Hayden. After the first publication of their description of this species in the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1858, they expressed great doubt (Paleontology of the Upper Missouri, 1864), whether it is really different from *H. crinistria* Phillips (*sp.*) of Europe. The genus *Hemipronites* is also freely represented by different varieties in the Subcarboniferous strata of the States just named, so far as they exist there. After long study of these forms, from the strata of both periods, I have failed to discover entirely satisfactory grounds for the *specific* discrimination of more than one group.

While I am not prepared to deny that there may be more than one species of *Hemipronites* among those hitherto described from the various strata referred to, I have at present very little doubt that the species long known as *H. crassus* ranges through all the strata of both the Subcarboniferous and Carboniferous periods in the States before named, and that the species is identical with *H. crinistria* Phillips. The reader is referred to the following works for descriptions and illustrations of most of the varieties of *Hemipronites* that have been published from strata of the Carboniferous age in America:—Geology of Iowa, Hall, vol. i, part ii, 1858; Paleontology of the Upper Missouri, Meek and Hayden, 1864; Transactions of the Chicago Academy of Sciences, vol. i, part i, 1867; United States Geological Survey of Nebraska, 1872; and Carbonformation und Dyas in Nebraska, Geinitz, 1866.

Position and locality.—Strata of the Carboniferous period:—Meadow Creek, south of Fillmore; Star district, Picacho range; North Fork of Lewiston Cañon, Oquirrh range; below Ophir City; Kanab Cañon,

Wasatch range; pass between Rush and Cedar Valleys; and east side of Mount Nebo, Utah; top of Grass Mountain, Ely range; Fossil Hill; Camp Apache; old Potosi mine; Tenney's Ranch; Kaibab Plateau; and at the confluence of White Mountain and Black Rivers, Nevada.

GENUS ORTHIS Dalman, 1828.

Orthis Pecosii Marcou.

Plate IX, fig. 5 *a*, *b*, *c*, *d*, and *e*.

Orthis Pecosii Marcou, 1858*, Geol. North America, 48.

Orthis carbonaria Swallow, 1858, Trans. St. Louis Acad. Sci., i, 218.

Orthis carbonaria Meek, 1872, U. S. Geol. Surv. Nebraska, 173.

Shell small, sublenticular; outline subcircular or subovate; length and breadth nearly equal, but sometimes the length is a little the greatest; front margin regularly rounded or slightly emarginate; hinge-line very short, less than half the breadth of the shell. Ventral valve having its greatest convexity at the umbo, often flattened a little at the front, but without a definite mesial sinus; beak small, pointed, somewhat prominent, and arched over the small, well-defined area, which arches with it.

Dorsal valve more convex than the ventral in old shells, its greatest convexity being behind the middle, generally having a mesial flattening extending from the umbo to the front, but no definite mesial sinus; area distinct, but smaller than that of the other valve; beak small, not prominent.

Surface of both valves marked by fine, close-set, radiating striæ, which increase mainly by implantation, but occasionally by bifurcation; the striæ crossed by fine concentric lines of growth, and, toward the front of old specimens, by imbricating lines.

The striæ often show small pores upon their backs, apparently marking the former places of minute tubular spines.

* *Orthis Pecosii*, *Retzia Mormonii*, *Rhynchonella Uta*, *R. Rockymontana*, and *Spirifer Rockymontana* were published by Marcou in his Geology of North America. I have obtained satisfactory evidence that the work was published as early as March 1, 1858. Vol. xv of the Bulletin de la Société Géologique de France contains a statement that a copy of the book was sent to that society on April 20, 1858. In the same year, Shumard and Swallow published a paper containing descriptions of the three first-named species, under other names, in the Transactions of the St. Louis Academy of Sciences, but that publication was not made until about the first of June. In December of the same year, Hall published in the Geological Report of Iowa, *Spirifer Rockymontana* as *S. opimus*; and in 1860, McChesney published *R. Rockymontana* as *R. cloniformis*. It thus appears clear that Marcou is entitled to priority of all five of the names above given, as stated in the synonymy heading the descriptions of those species in this report.

Width and length of a large specimen, each thirteen millimeters; but the average size is nearly one-third less.

This little shell belongs to a section of the genus *Orthis*, of which *O. Michilini* may be cited as the type, and of which *O. Pecosii* is the only representative known to me in American strata above the Subcarboniferous. It is very constant in its specific characters, and has a wide geographical range. Professor Marcou's type-specimens were obtained from New Mexico, but it is not an uncommon shell in the Middle and Upper Coal-Measures of Illinois, Iowa, Missouri, Kansas, and Nebraska. There is a small species of *Orthis* in the Keokuk limestone (Subcarboniferous) of Iowa and Illinois, which is very closely related to this one. If it is not identical with *O. Pecosii*, the range of the latter is probably confined to strata of the Carboniferous period alone.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico.

GENUS MEEKELLA White and St. John, 1867.

Meekella striatocostata Cox, *sp.*

Plate IX, fig. 4 *a*, *b*, *c*, *d*, and *e*.

Plicatula striatocostata Cox, 1857, Geol. Report Kentucky, iii, 568.

Orthisina Shumardiana Swallow, 1858, Trans. St. Louis Acad. Sci., i, 183.

Orthisina Missouriensis Swallow, 1858, *ib.*, 219.

Streptorhynchus pyramidalis Newberry, 1861, Exp. Exped. Col. River, Paleont., 126.

Streptorhynchus occidentalis Newberry, 1861, *ib.*, 126.

Orthis striatocostata Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 48.

Meekella striatocostata White and St. John, 1867, Trans. Chicago Acad. Sci., i, pt. i, 120.

Meekella striatocostata Meek, 1872, U. S. Geol. Surv. Nebraska, 175.

Shell variable in size and shape, indistinctly trihedral in outline; both valves becoming gibbous at full adult age; hinge-line generally much shorter than the greatest breadth of the shell.

Ventral valve usually more capacious than the other, but sometimes the difference in this respect is slight, deepest near the umbo; beak almost always more or less distorted by being flattened, depressed, bent backward or toward one side or the other, usually toward the dextral side; area triangular, more or less irregular in consequence of the distortion of the beak; height of area seldom so great as its width at the base, and is often

much less, its lateral borders well defined, finely striated, both vertically and transversely; fissure varying in proportional width, but usually quite narrow, and completely closed by a pseudo-deltidium, which is more or less flattened along each side, prominent along the middle, along which prominence there is a slightly-raised mesial line.

Dorsal valve capacious, more regularly convex than the other; convexity so great behind the middle as to carry a portion of the valve a little behind the hinge-line, flattened a little toward the front, suggestive of a mesial sinus, but seldom or never possessing a true one; beak strongly incurved; not projecting over the cardinal border; area obsolete; postero-lateral portions laterally compressed, leaving small thin ears at the hinge-extremities.

Surface of each valve marked by from ten to fourteen, more or less angular, radiating plications, having deep, angular interspaces between them; plications not extending to the beak, increasing in size toward the front, mostly simple, but sometimes bifurcating; plications and interspaces both marked by numerous fine radiating striæ, which, toward the front margin of adult shells, usually converge to the crests of the plications, upon which they meet at acute angles; crossing these converging lines, there are also usually zig-zag lines of growth to be seen. The convergence of the radiating striæ does not take place until the shell has reached nearly mature size, and occasionally not then.

This shell is variable in size and shape, and to some extent in its surface-markings also; but its general characteristics are such as to separate it widely from any associated forms. Two principal varieties of the species have been recognized and published as separate species; but in the Upper Coal-Measure rocks of Iowa I have found these two varieties associated with such intermediate forms as to convince me that they are not specifically distinct. Some of these differences appear to be of such a character only as all species are subject to, and some of them are evidently due to difference in age alone.

I have not yet seen any American shell belonging to the genus *Meekeella* that I regard as specifically distinct from *M. striatocostata*. Compared with a specimen of *Streptorhynchus pectiniformis* Davidson, sent me from

England by that gentleman, from collections made in Punjab, India, many specimens of our shell are found to be specifically undistinguishable from it by external features; and, unless its internal characters should prove to be different, it cannot be regarded as specifically distinct from *M. striatocostata*. In Iowa and Nebraska, it is confined to strata of the Upper Coal-Measures.

Length of one of the specimens figured, twenty-five millimeters; breadth, twenty-six millimeters; height, twenty millimeters; but examples are occasionally found having nearly or quite double these dimensions, but in such large ones the height is not often proportionally so great.

Position and locality.—Strata of the Carboniferous period:—Camp Cottonwood, Lincoln County, Nevada: Tenney's Ranch, Kaibab Plateau, Arizona: Kanab Cañon; Meadow Creek, south of Fillmore; Le Verkin's Creek; and at a cliff east of Bellevue, Utah.

FAMILY RHYNCHONELLIDÆ.

GENUS RHYNCHONELLA Fischer, 1809.

Rhynchonella Uta Marcou, *sp.*

Plate IX, fig. 2 *a*, *b*, and *c*.

Terebratula Uta Marcou, 1858,* *Geology of North America*, 51.

Rhynchonella (*Camarophora*) *Osagensis* Swallow, 1858, *Trans. St. Louis Acad. Sci.*, i, 219.

Camarophora globulina Geinitz, 1866, *Carbonformat. und Dyas in Nebraska*, 38 (not

C. globulina Phillips, *sp.*, 1834).

Rhynchonella Osagensis Meek, 1872, *U. S. Geol. Surv. Nebraska*, 179.

Shell rather small, varying considerably in form, usually somewhat trihedral, and a little wider than long; postero-lateral margins converging at an angle, varying in different shells from eighty to one hundred and ten degrees; front broadly rounded, emarginate at the middle.

Dorsal valve more capacious than the ventral, abruptly convex at the front; beak strongly incurved; mesial fold not prominent, and perceptible only at the front; plications somewhat angular, from nine to twelve in number, becoming obsolete at the middle and sides of the valve; three or four of these plications are borne upon the mesial fold, and there are also three or four upon each side of it.

* See foot-note concerning date of publication on page 125.



Ventral valve rather shallow, similar to the other valve in number, distribution, and character of the plications; mesial sinus broad, shallow, and short, generally having two plications at its bottom, but sometimes three; all the plications in both valves disappearing about the middle, so that the surface of the posterior portion of the shell is almost entirely unmarked except by faint concentric lines of growth.

Usual length of adult examples about ten millimeters; breadth, eleven millimeters; but many much smaller examples are found, and the collections contain a few specimens figured on Plate IX, the dimensions of which are one-third greater than those given, and yet they seem evidently referable to this species.

This shell has quite a wide geographical range, being found in the Carboniferous strata of Illinois, Iowa, Missouri, Kansas, and Nebraska, and Professor Marcou obtained his type-specimens from near Great Salt Lake, Utah. So far as known, it is confined to the strata of the Carboniferous period. It is more nearly related to *R. Ottumwa* White than to any other shell known to me, the more gibbous examples of which it closely resembles.

Position and locality.—Strata of the Carboniferous period; North Fork of Lewiston Cañon, Oquirrh range, and at Meadow Creek, south of Fillmore, Utah.

Rhynchonella metallica White.

Plate X, fig. 10 *a*, *b*, *c*, and *d*.

Rhynchonella metallica White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 20.

Shell rather less than medium size, depressed, or moderately inflated when adult; transversely suboval in outline; antero-lateral borders abruptly rounded; front broadly rounded, but usually straightened or slightly emarginate at the middle; postero-lateral margins straightened, laterally compressed, and converging to the beaks at a very obtuse angle.

Dorsal valve more capacious than the ventral, broadly convex from side to side, a little flattened near the beak, abruptly bent downward at the margins; mesial fold broad, not much elevated, discernible only on the anterior part of the valve.

Ventral valve comparatively shallow, slightly convex from side to side;

convexity from the umbo to the antero-lateral margins about the same as it is from side to side; beak small, prominent, and incurved over that of the dorsal valve; mesial sinus broad, becoming obsolete near the middle of the shell, and is entirely wanting upon the posterior portion.

Surface marked by from fourteen to sixteen simple, angular, plications upon each valve, with angular interspaces of similar width between them, all of which are continuous from the front to the beaks; about four of these plications are borne in the mesial sinus, and five of them upon the mesial fold.

Length, ten millimeters; breadth twelve, millimeters; height, seven millimeters.

This shell is more nearly related to *R. Cooperensis* Shumard from the Subcarboniferous strata of Missouri than any other species with which I am acquainted; but it differs in having a less number of plications, and in wanting the numerous filiform striae that mark the surface of that shell.

Position and locality.—Strata of the Carboniferous period; Old Potosi Mine, Lincoln County, Nevada.

***Rhynchonella Wasatchensis* White.**

Plate IX, fig. 3 *a*, *b*, *c*, and *d*.

Rhynchonella Wasatchensis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 19.

Shell under medium size, sublenticular or subglobose; valves nearly alike in their convexity; length equal to, or slightly greater than, the breadth; antero-lateral and front margins somewhat regularly rounded, the front being slightly straightened or a little emarginate; postero-lateral margins converging to the beaks at an obtuse angle.

Dorsal valve broadly convex from side to side; convexity from beak to front regular but a little greater than it is transversely; umbo prominent; beak strongly incurved; mesial fold obsolete or wanting.

Ventral valve strongly and somewhat regularly arching from beak to front; convexity from side to side a little less than it is longitudinally and about the same as the transverse convexity of the other valve; beak somewhat prominent and incurved over the beak of the dorsal valve; mesial sinus obsolete or wanting.

Surface marked by a few obscure radiating striae, which are most conspicuous near the median line of each valve; fine concentric striae are numerous, and in the adult shell there are also strong imbricating lines of growth near the front and lateral margins.

Length, fifteen millimeters; breadth, fourteen millimeters; height, twelve millimeters.

This shell is not only without the plications so common to the paleozoic species of *Rhynchonella*, but it has also a different general aspect. This has caused some doubts to arise as to the propriety of referring it to that genus, but the broken ventral beak shows no other characters than those of *Rhynchonella*, and the shell-structure is also distinctly fibrous and not punctate.

Position and locality.—Strata of the Carboniferous period; Rock Cañon, Wasatch Range, near Provo, Utah, where only a single example was obtained.

***Rhynchonella Rockymontana* Marcou.**

Plate IX, fig. 1 *a*, *b*, *c*, and *d*.

Terebratula Rockymontana Marcou, 1858, Geology of North America, 50.

Rhynchonella eatoniaformis McChesney, 1860, Description New Pal. Fossils, 49.

Shell rather large, inflated, subtriangular in outline, broadest near the front; sides somewhat regularly rounded from the antero-lateral portions to the beaks. Ventral valve having its greatest convexity toward the beak; sides sloping away from the middle with slight convexity and becoming flattened or sometimes even a little concave near the lateral margins; beak rather small, prominent, and closely incurved over that of the other valve; mesial sinus very broad but not deep, prolonged far upward at the front, becoming obsolete about the middle of the valve and is entirely wanting upon its posterior portion; from two to four depressed angular plications occupy the mesial sinus and disappear with it, the sides and posterior portion being free from plications. Dorsal valve more capacious than the ventral; mesial fold distinct at the front, and, like the mesial sinus, becoming obsolete about the middle of the valve; from three to five plications like those of the other valve mark the fold, but the surface upon each side of it is plain like that of the posterior portions of both valves. The whole

surface marked by fine striae of growth, but no radiating striae have been detected.

Length, twenty-five millimeters; breadth, twenty-six millimeters; height, seventeen millimeters.

The only American shell likely to be confounded with this species is *R. Missouriensis* Shumard, but it differs somewhat in outline and proportions as given in the description and figures of Dr. Shumard and also in the character of the plications. There is a shell in the Kinderhook formation at and in the vicinity of Burlington, Iowa, which is usually referred to *R. Missouriensis*. If that shell is correctly so referred, it differs materially from *R. Rockymontana* in being plainly marked by numerous distinct, radiating striae upon both valves. This shell is also very closely like *R. reniformis* Sowerby from the Carboniferous strata of England, and may possibly be identical with it.

Position and locality.—Strata of the Carboniferous period; near Beckwith Spring, Cedar range, Utah. Professor Marcou obtained his type-specimens from Pecos Village, New Mexico, where he found them associated with *Productus semireticulatus* and *Spirigera subtilita*.

FAMILY SPIRIFERIDÆ.

GENUS SPIRIFER SOWERBY, 1815.

Spirifer cameratus Morton.

Plate X, fig. 1 *a*, *b*, *c*, and *d*.

Spirifer cameratus Morton, 1836, American Journal Science, xxix, 150.

Spirifer triplicatus Hall, 1852, Stansbury's Expedition Great Salt Lake, 410.

Spirifer Meusebachanus Roemer, 1852, Kreidebildung von Texas, 88.

Spirifer cameratus Hall, 1856, Pacific Railroad Surveys, iii, 102.

Spirifer cameratus Hall, 1858, Geology of Iowa, i, pt. ii, 709.

Spirifer cameratus Meek, 1872, U. S. Geol. Surv. Nebraska, 183.

Shell usually of medium size, but sometimes quite large, subsemicircular or subtriangular in outline, almost always broadest at the hinge-line; the hinge-extremities often pointed and sometimes mucronate.

Dorsal valve not quite so capacious as the other; mesial fold distinct, broad at the front, sometimes sharply elevated, but more commonly rounded, clearly defined from front to beak, and rapidly increasing in width to the

front by the greater or less curving-outward of the sides; sides of the valve sloping almost directly from the mesial fold to the lateral borders; antero-posterior convexity of the mesial fold very slight from front to middle, but increasing from the middle to the beak; beak small, projecting slightly over the cardinal border.

Ventral valve strongly arching from beak to front, the beak being prominent, pointed, and curved over the area; area concave, of moderate width, and not narrowing to a sharp angle at the hinge-extremities; foramen almost equilaterally triangular, partially closed by a pseudo-deltidium, which is often removed by weathering; mesial sinus well defined from front to beak, and in all respects answering to the mesial fold of the other valve.

Surface marked by numerous distinct, rounded striæ of unequal size, which increase gradually in size toward the front; striæ increasing in number by the division near the beak of the few that are continuous to its point; they are thus generally gathered into more or less distinct fascicles of three or more striæ in each, the middle striæ of the fascicle being the most prominent, and also the one that reaches the point of the beak; the mesial fold and sinus usually have striæ of the same character and arrangement as the sides of the shell have, but in some rare cases they are obsolete upon the sides of the fold and sinus respectively. Besides the radiating striæ the usual concentric lines and occasional coarser marks of growth exist.

Length of a good-sized example, thirty-two millimeters; breadth, at the hinge-line, forty-three millimeters; height, twenty-two millimeters.

This is one of the most common species in American strata of the Carboniferous period, and may generally be identified without hesitation, but there are some varieties of it that give more trouble in satisfactory identification. One variety has been described by Professor Swallow as var. *Kansasensis*, which is more than usually transverse, and the striæ nearly uniform in size, and not fasciculated, as they are in typical examples, approaching in these respects *S. striatus* Martin, *sp.*

Position and locality.—Strata of the Carboniferous period:—Fossil Hill, White Pine County; Ely range; Old Potosi Mine, Lincoln County, and Egan range, thirty-five miles south of Egan Pass, Nevada; Camp Apache,

Maricopa County; Salt River; confluence of White Mountain and Black Rivers; and Cañon Butte, Arizona; Oquirrh range, near Camp Floyd; Lake range, on Fairfield road; west face of Oquirrh range; North Fork of Lewiston Cañon, Oquirrh range; cliff east of Belleview; Meadow Creek, south of Fillmore; North Star district, Picacho range; near Beckwith Spring, Cedar range; Rock Cañon, Wasatch range, near Provo, and Virgin range, southwest of Saint George, Utah.

Spirifer striatus Martin, *sp.*

The collections contain some examples of *Spirifer* that are more or less imperfect, but which are so closely like *S. striatus* that I am unwilling at present to make any other assignment of them. They are from strata of the Carboniferous period, near Fort Bayard, New Mexico, and the North Star district, Picacho range, Utah.

They seem to be different from Professor Swallow's variety of *S. cameratus* before mentioned, and are evidently identical with the shell referred by Professor Marcou to this species in his Geology of North America, examples of which he obtained in part from localities not far distant from those at which ours were obtained. Specimens of this species were also obtained from the Subcarboniferous strata at Mountain Spring, old Mormon road, Nevada, which are noticed on a previous page.

Spirifer rockymontanus Marcou.

Plate XI, fig. 9, *a*, *b*, *c*, and *d*.

Spirifer rockymontani Marcou, 1858,* Geol. North America, 50.

Spirifer opimus Hall, 1858, Geol. Iowa, i, pt. ii, 711.

Spirifer subventricosa McChesney, 1860, Deser. New Paleozoic Foss., 44.

Shell very variable in outline, some examples being scarcely broader than long, while the length and breadth of others have the relative proportions of seven to ten; regularly rounded in front of the hinge, the hinge-line being usually a trifle shorter than the breadth of the shell immediately in front of it; the valves are of almost equal capacity, and more or less gibbous. Ventral valve having a moderately well-defined mesial sinus,

* See foot-note on page 125 concerning date of publication of this species.

which is wide at the front, and distinctly defined from front to beak; area of moderate width, concave, the beak being strongly incurved over it.

Dorsal valve having a mesial fold corresponding in shape and distinctness with the sinus of the other valve; beak not prominent, projecting very little over the cardinal border.

Surface of each valve bearing from twenty-four to thirty radiating plications, distributed over the sides and also upon the fold and sinus; the middle plications somewhat larger than any of the others, the size diminishing gradually toward the postero-lateral regions.

The numerous specimens of this species in the collections present most perplexing variations, and I have repeatedly been almost persuaded to arrange some of them under a separate specific name, but the presence of intermediate forms has prevented such a decision. I have no doubt of the specific identity of our shell with *S. Rockymontanus* Marcou, and it will also be noticed that some of our examples were obtained from near the same localities that furnished the type-specimens used by Professor Marcou in writing his description. Many of the examples under examination agree in all essential particulars with *S. opimus* Hall, which thus becomes a synonym of *S. Rockymontanus*. Compared with figures and descriptions of *S. bisulcatus* Sowerby from the Subcarboniferous strata of Great Britain, some of our examples agree so closely that I suspect this American shell may, after all, prove to be identical with that European species.

Position and locality.—Strata of the Carboniferous period: North Fork of Lewiston Cañon, Oquirrh range, and upon the west face of Oquirrh range, Utah; also near Santa Fé, New Mexico.

SUBGENUS MARTINIA McCoy, 1844.

***Spirifer (Martinia) planoconvexus* Shumard.**

Plate X, fig. 3 *a*, *b*, and *c*.

Spirifer planoconvexus Shumard, 1855, Geological Report of Missouri, 202.

Ambocælia gemmula McChesney, 1860; Descr. New Paleozoic Fossils, 41.

Spirifer planoconvexus Meek and Hayden, 1864, Paleont. Upper Missouri, 20, 21.

Spirifer planoconvexus Geinitz, 1866, Carbonformation und Dyas in Nebraska, 42.

Compare with *Spirifer Uriei* Fleming, 1828, British Animals, 376.

Shell very small; breadth varying from a little more to a little less than the length; hinge-line of considerable length, but always shorter than

the full breadth of the shell in front of it; lateral and front borders regularly and continuously rounded.

The dorsal valve would be almost circular but for its truncation by the hinge-line, nearly flat, but slightly convex at the umbo, and sometimes slightly concave at the front; beak minute, not prominent; area very narrow.

Ventral valve capacious, especially its posterior portion, which extends much behind the hinge-line, and ends in a prominent, strongly incurving, pointed beak; area very narrow, high, concave; mesial sinus absent, but in its place there is usually a slight flattening at the front, and sometimes an indistinctly impressed line is to be seen extending from beak to front.

Surface apparently smooth, but under a lens it is seen to be finely granular, the apparent granules being the bases of minute setæ; a few concentric lines of growth are usually observable upon both valves.

This shell agrees so closely in many respects with *S. Uriei* Fleming, from the British Carboniferous strata, that the propriety of placing it under any other specific name may well be questioned. In view, however, of the fact that the characteristics of this subgenus admit of the development of very few salient specific characters, I am at present disposed to regard these minor differences as affording sufficient reason for continuing the use of Shumard's name. It is one of the most common species in American rocks of the Carboniferous period, having been found in the Coal-Measure strata of Virginia, Pennsylvania, Illinois, Missouri, Iowa, Nebraska, and Kansas, besides the regions that have supplied it to our collections, being generally most abundant in the upper portion of the series. It is often gregarious; some portions of the strata in which it occurs being composed mainly of shells of this species alone. The collections, however, contain comparatively few examples.

Position and locality.—Strata of the Carboniferous period: near Santa Fé, New Mexico; and at Elko Mountain, Nevada.

Spirifer (Martinia) glaber var. contracta Meek and Worthen.

Plate X, fig. 2 *a*, *b*, and *c*.

Anomites glaber Martin, 1809, *Petrificata Derbiensia*, pl. xlviii, figs. 9, 10.

Spirifer glaber Sowerby, 1820, *Mineral Conchology*, iii, 123.

- Trigonotreta oblata* Brunn, 1836, Lethæa Geognostica, i, 81.
Spirifer glaber Phillips, 1836, Geology of Yorkshire, ii, 219.
Spirifer lævigatus von Buch, 1840, Mém. de la Soc. Géol. de France, iv, 198.
Spirifer glaber de Koninck, 1844, Animaux Fossiles de la Belgique, 267.
Martinia glabra McCoy, 1844, Synopsis Carb. Fossils of Ireland, 139.
Spirifera glabra McCoy, 1855, British Palæozoic Fossils, 428.
Spirifera glabra Davidson, 1857, Monog. British Carb. Brachiopoda, 59.
Spirifer glaber var. *contracta* Meek and Worthen, 1866, Geol. Surv. of Illinois, ii, 298.

Shell reaching about medium size, rotund, gibbous, or becoming much inflated with age; length and breadth usually about equal; hinge-line short, not quite equal to half the transverse diameter of the shell. Dorsal valve less capacious than the other, subcircular, broadly rounded in front, most convex near the beak; the beak is small, slightly prominent, and projects trifle over the cardinal margin. Ventral valve capacious, arcuate; umbo extended much behind the hinge-line, especially in adult shells; mesial sinus absent or obsolete; beak prominent, pointed, and strongly incurved; area narrow laterally, moderately high, concave, lateral borders obscurely defined; foramen comparatively large, occupying the greater part of the area.

Surface apparently smooth, but under a lens fine concentric lines are seen, which appear to have been the seat of concentric rows of very minute setæ; concentric folds are also sometimes present, especially toward the margins of old shells.

Length and breadth of the largest specimen in the collection, each six millimeters; height, twenty millimeters; but this is considerably larger than the average size of the others, and the height is proportionally greater.

The type-specimens of this variety of *S. glaber* were obtained by Meek and Worthen from the Chester limestone (Subcarboniferous) at the town of Chester, Illinois. Our shell agrees so exactly with it that I feel compelled to refer it to that variety notwithstanding the fact that it was obtained from strata of another and later period. The principal observable difference between ours and Meek and Worthen's type-specimens seems to be a nearer approach in their shell to a defined mesial sinus than in ours, but this difference may be no more than an individual one. If it is not referable to this variety, I am not able at present to refer it to any other than the original European species. It especially resembles a variety from Yorkshire,

England, which Mr. Davidson illustrates on Plate XII, figs. 8, 9, and 10, of his Monograph of British Carboniferous Brachiopoda, and refers with doubt to *S. glabra*.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, Lincoln County, Nevada.

GENUS SPIRIFERINA d'Orbigny, 1847.

Spiriferina Kentuckensis Shumard.

Plate X, fig. 4 *a*, *b*, and *c*.

Spirifer octoplicatus Hall, 1852, Stansbury's Exped. Great Salt Lake, 409 (not *S. octoplicatus* Sowerby).

Spirifer Kentuckensis Shumard, 1855, Geol. Surv. Missouri, 203.

Spirifer laminosus Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 45 (not *S. laminosus* McCoy).

Spiriferina Kentuckensis Meek, 1872, U. S. Geol. Surv. Nebraska, 185.

Shell small, very variable in outline, usually subsemicircular, but sometimes the hinge-extremities are mucronate, and sometimes so shortened that the shell is subglobose in form, but it is always broader than long. Ventral valve more capacious than the other; beak prominent, arching backward; area moderately high, well defined, concave; foramen higher than wide; mesial sinus distinctly defined, rather narrow, often moderately deep, without plications, except occasionally a small obscure one at the bottom. Dorsal valve somewhat regularly convex; beak scarcely prominent, projecting very slightly over the cardinal margin; mesial fold narrow, distinctly defined, a faint linear depression sometimes observable along its middle corresponding with the small linear plication sometimes seen at the bottom of the sinus of the ventral valve.

Surface of each valve marked by from ten to eighteen simple prominent plications, rounded or almost angular at top, and having interspaces of similar width between them; the plications bounding the sinus are a little larger and a little more prominent than the others, which thus serve to more clearly define the sinus from the remainder of the shell. The entire surface is also marked by fine, distinct, prominent, and closely-crowded lines of growth.

Length of a specimen, of about average size and proportions, nine millimeters; breadth between the hinge-extremities, thirteen millimeters.

Mr. Meek, in his Paleontological Report for the United States Geological Survey of Nebraska, has pointed out the close relationship of the more compact forms of this species with *S. octoplicata* Sowerby from the Subcarboniferous strata of Europe, but expresses a doubt of its specific identity with the European shell. That it is really distinct from *S. octoplicata* is now apparently proven by the discovery in strata of the same period, and among the associates of *S. Kentuckensis*, of a species that seems to be unquestionably identical with the former species, and as certainly different from the latter.

Position and locality.---This species is quite a common one in the Carboniferous strata of Kentucky, Illinois, Missouri, Iowa, Nebraska, Kansas, and Texas; but I am not aware that it has ever been discovered in strata of the Subcarboniferous period. The collections contain it from strata of the Carboniferous period from near Santa Fé, New Mexico, at Meadow Creek, south of Fillmore, Utah, and Camp Apache, Arizona. The species is represented by an unexpectedly small number of specimens.

Spiriferina octoplicata Sowerby.

Plate X, fig. 8 *a*, *b*, and *c*.

Spirifer octoplicatus Sowerby, 1827, Mineral Conchology, 120.

Spirifer cristatus von Buch, 1837, Ueber Delthyris, 39.

Spirifer cristatus McCoy, 1855, Synopsis Carb. Foss. Ireland, 133.

Spiriferina cristata var. *octoplicata* Davidson, 1857, Monog. British Carb. Brachiopoda, 38.

Spiriferina spinosa var. *campestris* White, 1874, Expl. & Surv. west 100th Merid., Prelim. Report Invert. Foss., 21.

Shell rather under medium size, suboval or somewhat tetrahedral in outline, broader than long, more or less gibbous; hinge-line extended, not mucronate, but usually a trifle shorter than the greatest breadth of the shell; valves of almost equal capacity.

Mesial fold of the dorsal valve narrow, plain, distinctly defined from front to beak, elevated at the front of the more gibbous examples; beak of the valve slightly projecting over the cardinal margin. Mesial sinus of the ventral valve plain, narrow or of moderate width, distinctly defined from front to beak, sometimes extended much upward at the front; beak of the valve prominent, incurved, its area moderately high and gently arching.

Surface marked by from four to six strong, prominent, simple plications on each side of the mesial fold and sinus respectively. The whole surface is also marked by fine granulations, and, near the front especially, by concentric lines of growth, but no spines have yet been detected. Exfoliated portions of the shell show its structure to be coarsely punctate.

Length of a robust example, sixteen millimeters; breadth, twenty-one millimeters; height, fourteen millimeters.

This species, as represented in the collections, has all the characteristics of the typical forms of *S. octoplicata*. *S. Kentuckensis* Shumard has been by some authors referred to that species, but our shell is distinguished from Shumard's species by its greater size, its more robust form, less numerous and larger plications, and in the absence of the fine, prominent, concentric striation which that species possesses. It is very closely related to *S. spinosa* Norwood and Pratten, from the Chester limestone of the Subcarboniferous period at Chester, Illinois. Indeed, almost the only difference I am able to detect between them is the apparently entire absence of spines from the surface of our examples, which characterize that species. Since we often find among other species of spine-bearing Brachiopods that there is a very great variation in the number of spines, even upon specimens associated together in the same strata, it may not be unreasonable to suppose that our shell has lineally descended from *S. spinosa*, suffering little or no change other than the loss of its spines during the transition from one geological period to the other. In my preliminary report, I regarded the examples contained in the collections as those of a variety of *S. spinosa*, but even that species is not unlikely a variety of *S. octoplicata*. In any case, further comparison has convinced me that our examples agree more nearly with the last-named species than with *S. spinosa*.

This supposition of lineal descent seems to be supported by the fact that more than one species found common in the Chester limestone formation is distinguishable from certain Coal-Measure forms only with great difficulty, if at all.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico, and at Camp Cottonwood, Lincoln County, Nevada.

GENUS RETZIA King, 1850.

Retzia Mormonii Marcou.Plate X, fig. 7 *a*, *b*, and *c*.

- Terebratula Mormonii* Marcou, 1858,* Geology of North America, 51.
Retzia punctilifera Shumard, 1858, Trans. St. Louis Acad. Sci., i, 220.
Retzia Mormonii Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phila., 27.
Retzia subglobosa McChesney, 1860, Descr. New Pal. Fossils, 45.
Retzia Mormonii Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 39.
Retzia punctilifera Meek, 1872, U. S. Geol. Surv. Nebraska, 189.

Shell small, ovate in outline, both valves more or less gibbous; hinge-line short; ears very minute, and observable only in well-preserved examples. Ventral valve a little more capacious than the dorsal; posterior portion narrowed to the umbo, which is prominent and considerably arched; beak small, truncated by a foramen of moderate size; area small but well defined. Dorsal valve almost as prominently convex as the ventral; umbo prominent; beak incurved and extending a trifle over the cardinal border.

Surface of each valve marked by from fourteen to seventeen simple, narrow, radiating costæ, having interspaces of similar width; costæ sharply elevated, their backs, as well as the bottoms of the interspaces, somewhat flattened; mesial fold and sinus wanting or obsolete.

This shell is a characteristic and not uncommon one in the Carboniferous strata of Illinois, Missouri, Iowa, Nebraska, and Kansas, but it is represented by only a few examples in the collections.

Position and locality.—Strata of the Carboniferous period; near Santa Fé, New Mexico, and top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada. Professor Marcou obtained his type-specimens from Utah.

GENUS SPIRIGERA d'Orbigny, 1847.

Spirigera subtilita Hall.Plate X, fig. 6 *a*, *b*, and *c*.

- Terebratula subtilita* Hall, 1852, Stansbury's Exped. Great Salt Lake, 409.
Terebratula? subtilita Davidson, 1857, Monog. British Carb. Brach., 18.
Spirigera subtilita Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phila., 20.

* See foot-note concerning date of publication on page 125.

Athyris subtilita Newberry, 1861, Exp. Exped. Colorado River, Paleontology, 126.

Athyris subtilita Davidson, 1863, Fossils of Southern India, pl. ix, fig. 7.

Athyris subtilita Meek, 1872, U. S. Geol. Surv. Nebraska, 180.

Compare *Athyris subquadrata* Hall, 1858, Geology of Iowa, i, part ii, 703.

Shell of moderate size, varying considerably in outline, but is generally subovate; seldom, if ever, as wide as it is long, moderately gibbous, but sometimes old shells are much inflated. Ventral valve generally a little more capacious than the dorsal; beak prominent, strongly incurved; mesial sinus not very deep, even at the front, and becoming obsolete about the middle; a more or less distinctly-impressed line usually exists along the bottom of the sinus, extending from front to beak.

Dorsal valve somewhat uniformly convex, but most prominently so near the umbo; beak small, slightly prominent; mesial fold not distinctly defined.

Surface marked by concentric striæ and by occasional imbricating lines of growth; faint traces of radiating striæ, such as are common on shells of this genus, are also occasionally seen.

Length of a specimen of ordinary size, twenty-four millimeters; breadth, twenty millimeters; height, nine millimeters.

In all the variations this shell is subject to, it is easily recognized after an acquaintance with the species has once been formed. One of the most noticeable of its constant characteristics is the impressed mesial line at the bottom of the sinus of the ventral valve, and extending from front to beak. This feature is rarely obscure, and usually distinct.

This species ranges through the whole series of strata of the Carboniferous period into the Permian, according to Mr. Meek; but it has not yet been recognized in the Subcarboniferous rocks of America, unless *S. sublamellosa* Hall, from the Chester limestone of Illinois, should prove to be a variety of this species. In England and India, however, it has been recognized in Subcarboniferous strata. Besides the localities at which it was collected by the exploring parties, it has been obtained from the Carboniferous strata of West Virginia, Ohio, Illinois, Missouri, Iowa, Nebraska, and Kansas, and also from the Permian rocks of the latter State.

Position and locality.—The following are the localities that have furnished the species to the collections:—Carizo Creek, Maricopa County;

Camp Apache; Tenney's Ranch, Kaibab Plateau; confluence of White Mountain and Black Rivers; Grass Mountain, thirty-five miles north of Pioche; and foot-hills of Dragoon Mountains, Arizona: Fossil Hill, White Pine County; and Camp Cottonwood, Nevada: fifteen miles south of Saint George; near Ophir City; Rock Cañon, Wasatch range, near Provo; and near Minersville, Utah.

Spirigera planosulcata Phillips, *sp.*

Plate X, fig. 5 *a*, *b*, *c*, and *d*.

Spirifer planosulcata Phillips, 1836, Geology of Yorkshire, ii, 220.

Terebratula planosulcata Marcou, 1858, Geology of North America, 52.

Compare *Athyris sublamellosa* Hall, 1858, Geology of Iowa, i, pt. ii, 702.

Compare *Athyris crassiscardinalis* White, 1860, Jour. Bost. Soc. Nat. Hist., vii, 229.

Compare *Athyris planosulcata*? Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 254.

Shell rather small, having a subtetrahedral, subpentahedral, or subcircular outline; both valves more or less gibbous; greatest breadth a little behind the middle, the valves almost equally capacious. Ventral valve without a proper mesial sinus, but in its place there is usually to be seen a slight mesial attenuating extending from the front to about the middle; beak small, prominent, curving upward so as to bring its small foramen about on a plane with the margin of the valve. Dorsal valve broadly convex, but it is in most cases mesially flattened a little at the front, like the ventral valve; this slight flattening of both valves produces a little straightening or truncation of the otherwise broadly-rounded front border.

Surface marked by numerous imbricating lines of growth and occasionally by faint traces of radiating striæ.

Length of an average-sized example in the collections, twelve millimeters; breadth, thirteen millimeters; height, eight millimeters.

The characteristics of this little shell as represented in the collections are quite constant, and it seems to agree in all essential respects with the species to which it is here referred; but, so far as I have been able to make comparisons, I am not without some doubt as to its specific identity with *S. planosulcata*, nor can I satisfactorily refer it to any other described species. In external characters, which are the only ones that have been observed in the shell under discussion, it agrees almost exactly with *S. crassiscardinalis*

White from the Subcarboniferous strata at Burlington, Iowa. In general aspect, it is rather more nearly like that shell than the one which Meek and Worthen have referred (*loc. cit.*) to *S. planosulcata* from the Keokuk limestone of Illinois. If the species here described should be referred to any described American species, it ought, I think, to be referred to *S. crassicaudinalis* White.

Position and locality.—Strata of the Carboniferous period: Santa Fé, New Mexico; and Rush Creek, Lake County, Colorado.

FAMILY TEREBRATULIDÆ.

GENUS TEREBRATULA Lhwyd, 1698.

SUBGENUS DIELASMA King, 1859.

***Terebratula* (*Dielasma*) *bovidens* Morton.**

Plate XI, fig. 10 *a*, *b*, and *c*.

Terebratula bovidens Morton, 1836, Am. Jour. Sci. & Arts, xxix, 150.

Terebratula millepunctata Hall, 1856, Pacific Railroad Surveys, iii, 101.

Terebratula geniculosa McChesney, 1860, Deser. New Pal. Fossils, 82.

Terebratula bovidens Meek, 1872, U. S. Geol. Surv. Nebraska, 187.

Dielasma ? *bovidens* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 21.

Shell ovate or elongate-ovate in outline; sides behind the middle laterally compressed, where also the shell is narrower, and its vertical diameter greater than in front of the middle. Ventral valve strongly arcuate from beak to front, the curvature being greatest behind the middle, rather more capacious than the other valve; beak prominent, incurved, but not coming quite in contact with that of the dorsal valve; foramen moderately large, not squarely truncating the beak, but opening obliquely backward; mesial sinus broad, and more or less distinct at the anterior part of the valve, but becoming obsolete at or behind the middle; dental plates extending but little, if any, in front of the teeth, placed so near the sides of the beak that the space between them and the sides of the shell is very narrow. Dorsal valve generally almost straight along the median line from the front margin to a little behind the middle, from which part it gently curves to the beak; gently and somewhat uniformly convex from side to

side, without a mesial fold, except that sometimes the front margin is slightly raised to conform to the shallow sinus of the other valve; character of the loop not fully determined, but it is known to reach farther forward than the middle of the shell.

Surface nearly smooth; shell-structure finely punctate.

This shell varies considerably in size and shape; one specimen in my private collection from Nebraska measuring three centimeters in length, and is proportionally broad. Some in the collections from near Santa Fé are unusually elongate, in which respect they seem to possess somewhat definite varietal characters; one of them measuring about twenty-five millimeters in length, thirteen millimeters in breadth, and ten millimeters in height. The average size is about seventeen millimeters long and twelve or thirteen millimeters broad.

The presence of an elongated brachial loop in this shell, together with the dental plates in the beak of the ventral valve, plainly shows that its reference hitherto to the genus *Terebratula* proper is incorrect. Fragments of the loop have been seen by breaking some of the solidly-filled shells of the collections, but the best observations of that kind were made upon some examples from Iowa. These were filled with calcite in the process of their mineralization, the transparency of which allowed the loop to be seen by transmitted light after the shell had been ground off, and polished above and below. Only the general form and extent of the loop were ascertained, as the details were obscured by the confused character of the crystalline filling; but it is apparently much like that of *Waldheimia*. Besides the dental plates, a broken example among the collections shows what is apparently the bird-sternum-like process of the dorsal valve that characterizes *Dielasma*, as described by Professor King; but this is not shown clearly. The subgenus *Dielasma* is evidently closely allied to *Cryptonella* Hall; and if it is not really identical, the differences are apparently confined to internal characters alone. *Cryptonella* is known to exist in the Subcarboniferous strata of Michigan; but its presence in strata of the Carboniferous period is not certainly known. So far as indicated by the species I at present refer to, *Dielasma*, the subgenus, seems to be confined to strata of the Carboniferous age, and to range through all three of its periods. Besides the species

here described, one is known to exist in the Subcarboniferous limestone of Washington County, Indiana; *D. Burlingtonensis* occurs in the Subcarboniferous strata at Burlington, Iowa, and in Nevada; and Professor Swallow has described one from the Subcarboniferous strata at Chester, Illinois, under the name of *Terebratula arcuata*, which is so nearly like *D. bovidens* that it is difficult to say wherein they differ. It has not thus far been discovered in the Permian strata of America, but it is understood to occur in strata of that period in Europe. The geographical range of *D. bovidens* is from Ohio to Nevada, and it has been discovered from base to top of the Coal-Measure series of strata.

Position and locality.—Strata of the Carboniferous period: near Santa Fé, N. Mex.; a few miles south of Saint George, Utah; and at the top of Grass Mountain, Ely range, thirty-five miles north of Pioche, Nevada.

MOLLUSCA VERA.

CLASS CONCHIFERA.

ORDER MONOMYARIA.

FAMILY PECTINIDÆ.

GENUS AVICULOPECTEN McCoy, 1852.

Aviculopecten occidentalis Shumard.

Plate XII, fig. 8 *a* and *b*.

Pecten occidentalis Shumard, 1855, Geol. Surv. Missouri, 207 (not Winchell, 1863).

Pecten Cleavelandicus Swallow, 1858, Trans. St. Louis Acad. Sci., i, 184.

Aviculopecten ———?, Meek and Hayden, 1864, Palæont. Upper Missouri, 50.

Pecten Missouriensis Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 35 (not Shumard, 1855).

Aviculopecten occidentalis 1872, U. S. Geol. Surv. Nebraska, 191.

Shell inequivalve, both ears well defined; the cardinal border at nearly right angles with the axis of the shell, and almost as long as its full antero-posterior diameter; outline, exclusive of the ears, subovate. Left valve more convex than the right; anterior ear about as long as the posterior, more convex, and a little more sharply defined from the body of the valve

than the other ear by the auricular furrow; obtuse at the extremity, inferior border concave; its surface marked by distinct radiating costæ, which are a little coarser than those upon the body of the valve, at the same distance from the beak; posterior ear clearly defined from the body of the valve by a shallow auricular furrow, sharply angular at the outer extremity; outer margin concave; surface marked by concentric lines, all radiate markings being absent or obsolete. Surface of the body of the valve marked by depressed flattened or very slightly convex, radiating costæ, which very gradually increase in size toward the free margins, and increase in number by implantation at different distances from the beak, only about a dozen of them reaching it. The implanted costæ, beginning as mere striæ between the others, are of unequal size on all parts of the valve; costæ crossed by numerous rather distinct concentric striæ.

Right valve flat or very slightly convex; beak flattened and not distinct at the cardinal border; costæ similar in character to those of the other valve, but they are not nearly so distinct; outline corresponding with that of the left valve, except that the anterior ear is narrower and defined by a deeper and sharply angular sinus.

Length from base to cardinal border, of an example somewhat above average size, forty-two millimeters; breadth, thirty-seven millimeters.

This shell is one of the most common Conchifers found in the Carboniferous rocks of Kentucky, Illinois, Missouri, Iowa, Nebraska, and Kansas. It is most abundant in the Upper Coal-Measures; but, according to Mr. Meek, it is found in the Lower Coal-Measures of Illinois, and also in the true Permian strata of Kansas.

Position and locality.—Strata of the Carboniferous period; Camp Apache, Arizona.

***Aviculopecten Coreyanus* White.**

Plate XI, fig. 1 *a* and *b*.

Aviculopecten Coreyanus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 21.

Shell moderately large; breadth not exceeding the height, and is usually a little less; margin of the basal half forming almost a true semicircle in some examples, but is less regular in others; posterior margin continued

thence in almost a direct line about half way to the cardinal margin; thence curving outward, it forms with the last-named margin a somewhat acute angle.

Hinge-line a little longer than the full breadth of the body of the shell and forming right angles with its vertical axis, extending farther backward than the posterior border below it does, but not reaching quite so far forward as the greatest convexity of the anterior border.

Left valve moderately convex, the greatest convexity being in the umbonal region; beak prominent and projecting a little beyond the cardinal border; posterior ear moderately large, acutely angular at the outer extremity, not distinctly defined from the body of the valve by an auricular furrow; anterior ear defined by a moderately deep byssal sinus and a distinct auricular furrow, not so prominent as the other ear; its outer border rounding downward and inward from the cardinal border into the byssal sinus, where it is met by the incurving anterior border of the body of the valve. Surface marked by numerous fine, radiating costæ of unequal size, which are in turn marked by very fine, radiating striæ, all of which are crossed by fine concentric lines of growth and occasional coarser lines of increment; upon the posterior ear, the radiating costæ are obsolete, but upon the anterior ear they are coarser than those of the body of the valve, and are also somewhat corrugated. Right valve unknown.

So far as the rather numerous, but more or less broken, examples of this shell will permit determination, the height, breadth, and length of the hinge-line are all nearly equal, being about six centimeters for the largest example.

This species somewhat resembles *A. occidentalis* Shumard, which is found in rocks of the same period, and perhaps associated with it; but it differs from that species in its greater proportionate breadth, in being less contracted below the ears, its less distinctly-defined posterior ear, its finer and rather more unequal costæ, and greater size.

Position and locality.—Strata of the Carboniferous period; Bear Spring, near Camp Wingate, New Mexico.

Aviculopecten McCoyi Meek and Hayden.

Plate XI, fig. 2 a.

Aviculopecten McCoyi Meek and Hayden, 1864, Palæont. Upper Missouri, 50.

Left valve moderately convex; height and breadth apparently about equal; posterior ear prominent, angular, its outer margin concave, and its surface marked by small, obscure, radiating costæ and numerous distinct lines of growth; anterior ear unknown. Surface of the body of the valve marked by six or eight strong elevated costæ, which have sudden enlargements, at irregular intervals, that are covered by vaulted, scale-like projections, giving the costæ a knotted appearance; the spaces between the large knotted costæ marked by numerous fine, distinct, slightly flexuous, raised striæ, which increase in number by implantation as the shell increases in size; the whole surface is also marked by fine concentric striæ and occasional coarser imbricating lines of growth. Full breadth of the shell about three centimeters. Right valve unknown.

The collections contain only a single imperfect left valve, but its surface-features are sufficiently characteristic to indicate its specific identity. In general aspect of the surface, this shell resembles that of *Pseudomonotis* or *Eumicrotis* rather more than an *Aviculopecten*; but the length of the hinge-line and the character of the posterior ear leave no doubt of its proper reference to the last-named genus, and its surface-markings and form, in addition, leave as little doubt as to its specific identity with *A. McCoyi* Meek and Hayden. These gentlemen obtained their type-specimens, from strata regarded by them as Permian, at South Cottonwood Creek, Kansas; while ours is evidently from a lower horizon.

Position and locality.—Strata of the Carboniferous period; near Bear Spring, Camp Wingate, New Mexico.

Aviculopecten ? interlineatus Meek and Worthen.

Plate XI, fig. 3 a.

Aviculopecten interlineatus Meek and Worthen, 1860, Proc. Acad. Nat. Sci. Phila., 454.
Aviculopecten interlineatus Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 329.

Shell rather small, broadly subovate in outline exclusive of the ears; breadth nearly equal to the height, slightly oblique, or the axis almost at

right angles with the cardinal border; hinge about equal in length to the full breadth of the shell; ears prominent, posterior one most so; anterior, basal, and posterior margins regularly and continuously rounded; beak depressed; umbonal slopes moderately distinct. Left valve slightly convex or nearly straight; posterior ear about the same size as the other, forming a nearly sharp angle with the cardinal extremity, its outer border being nearly straight; anterior ear triangular, well defined, its outer border slightly convex or nearly straight, and its extremity blunt. Surface marked by ten or twelve sharply-raised, slender, concentric ridges, each of nearly uniform width throughout, but each successively a trifle larger than the preceding one, separated, along the axis of the valve, by interspaces each four or five times as wide as the adjacent ridges, but the interspaces diminish in width toward the umbonal slopes, upon which the ridges are very near together; the latter then diverge in crossing the ears, and all end abruptly upon the cardinal border; surface between the ridges marked by numerous fine, uniform, concentric striæ, and also by very faint indications of radiating costæ.

Breadth, sixteen millimeters; height, from base to cardinal border, seventeen millimeters.

This interesting shell is rare; only the left valve having been discovered. The only other locality at which it has been found, so far as I am aware, is La Salle, Illinois, where the type-specimens of the species were obtained, and where it occupies a geological position similar to that from which our specimen was obtained.

It is so unlike any other known species of *Aviculopecten* that no comparison is necessary. Only the exterior of the left valve of this species is yet known, and Meek and Worthen have suggested that the undiscovered parts will, if discovered, be found to possess generic characters correlated with its peculiar surface-features that will separate the shell generically from *Aviculopecten*.

Position and locality.—Strata of the Carboniferous period; confluence of White Mountain and Black Rivers, Arizona.

FAMILY PINNIDÆ.

GENUS PINNA Linnæus, 1758.

Pinna peracuta Shumard (?).Plate XI, fig. 5 *a*.

From the Mesa edge, near Relief Spring, Arizona, a single specimen of *Pinna* was obtained, which is too imperfect for full specific determination. It has the aspect and general features of a young example of *P. peracuta* Shumard, to which species it probably belongs. Certain traces of lines of growth, however, indicate that our specimen was much more slender than the typical forms of that species, and also that the border below the middle sloped much farther forward than it is known to do in *P. peracuta*. The species associated with it are the associates of *P. peracuta* elsewhere, which adds force to the supposition that our specimen belongs to that species.

Examples of *P. peracuta* are not uncommon in the Carboniferous strata of the States bordering the Mississippi; but, although the collections contain a greater number of species from the strata of the Carboniferous period than any other, this is the only example of *Pinna* found among all the Paleozoic fossils.

FAMILY PTERIIDÆ.

GENUS MONOPTERIA Meek and Worthen, 1866.

Monopteria Marian White.Plate XI, fig. 4 *a*, *b*, and *c*.

Monopteria Marian White, 1874, Expl. Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 22.

Shell of moderate size, slender, nearly or quite equivalve, narrow and much extended posteriorly, the curvature being much the greater in the anterior half of the shell, the posterior half being nearly straight; body of the shell gradually tapering to near the posterior end, which is abruptly rounded; a more or less prominent ridge which is sometimes in part raised as a distinct carina, extends along the middle of the body of each valve from the beak to the posterior end; from this carina, or angle, the sides slope abruptly to both the inferior and upper borders, so that a cross-section

of the shell behind the ear would have a rhomboidal outline; beaks moderately prominent, separate; hinge equal in length to about one-half the full length of the shell, and its direction is nearly parallel with the posterior half of the body; posterior wing well developed, not sharply defined from the body by an auricular furrow; its cardinal portion narrow and moderately extended; anterior ear obsolete; lunule moderately large and deep, the borders of which are slightly prominent laterally, but its margins sharply rounded inward.

Surface smooth in aspect, but it is marked by very numerous fine lines of growth.

Length, from front to posterior extremity, about four centimeters; height, from base to hinge-margin, eighteen millimeters; average width of the body of the shell, about one centimeter.

This shell somewhat resembles *M. longispina* (= *Gervillia longispina* Cox) from the Coal-Measure rocks of Kentucky; but it differs conspicuously from that species in its more slender and less deeply-curved body, and in having a shorter ear-spine than that species is represented to have by Professor Cox's figure.

Position and locality.—Strata of the Carboniferous period; Camp Apache, Maricopa County, Arizona.

GENUS MYALINA de Koninck, 1844.

Myalina ——— (?).

Associated with the foregoing at Camp Apache, some imperfect specimens of *Myalina* were obtained, which appear to belong to *M. recurvirostris* Meek and Worthen.

Myalina? *Swallovi* McChesney.

Plate XI, fig. 8 *a*.

Associated with the two foregoing species at Camp Apache, Arizona, a few examples of *Myalina?* *Swallovi* were obtained, the best one of which is represented by fig. 8 *a*, Plate XI.

GENUS BAKEVELLIA King, 1848.

Bakevellia parva Meek and Hayden.Plate XI, fig. 7 *a* and *b*.*Bakevellia parva* Meek and Hayden, 1858, Trans. Albany Institute, iv.*Bakevellia parva* Meek and Hayden, 1864, Palæont. Upper Missouri, 57.

Shell very small, obliquely subovate in outline; valves gibbous, especially the anterior half of each; cardinal margin straight, its length not quite equal to the full length of the shell, forming an angle with its axis of about 30° ; postero-dorsal region compressed, subalate; antero-dorsal region bluntly prominent; ventral margin broadly rounded downward and backward; posterior margin abruptly rounded below, and straight or slightly concave above, inclining a little forward, and forming an obtuse angle with the cardinal margin.

Surface marked by fine concentric striæ.

Length of the largest specimen, six millimeters; height, about four millimeters.

The collections contain examples from two widely-separated localities. Those from New Mexico are from true Carboniferous strata, and differ slightly from the types and description of Meek and Hayden. Those from Arizona are from strata probably of the Permian period. A figure of each is given on Plate XI, which exhibit considerable difference in outline. This may perhaps be due to specific difference; but it is thought it is not necessarily so, as other examples seem to show intermediate forms. The type-specimens of Meek and Hayden were obtained from strata, regarded by them as Permian, near the mouth of the Smoky Hill Fork of Kansas River, Kansas.

Position and locality.—Strata at the summit of the Carboniferous series; Bear Spring, Camp Wingate, New Mexico; and also near Jacob's Pool, Arizona.

ORDER DYMYARIA.

FAMILY TRIGONIDÆ.

GENUS SCHIZODUS King, 1844.

Schizodus Wheeleri Swallow.Plate XI, fig. 6 *a* and *b*.*Cypricardia? Wheeleri* Swallow, 1862, Trans. St. Louis Acad. Sci., ii, 96.*Schizodus obscurus* Geinitz, 1866, Carbonformat. und Dyas in Nebraska, 20 (not Sowerby, 1821).*Schizodus Wheeleri* Meek, 1872, U. S. Geol. Surv. Nebraska, 209.

Shell of moderate size, irregularly subtrihedral or subovate in outline; posterior portion laterally compressed; anterior portion inflated; umbones elevated; beaks incurved, placed about one-quarter of the length of the shell from the anterior extremity; margins of the front and of the anterior part of the base forming a continuous and regular curve; basal margin sloping upward, and meeting the downward and backward slope of the posterior margin at a prominent angle, which is abruptly rounded; dorsal margin straight, sloping a little downward from the beaks to the obliquely-truncated posterior margin; posterior umbonal slope prominent, sometimes forming a rather distinct ridge, which ends at the prominent angle of the posterior margin and considerably increases its projection. Surface apparently unmarked except by concentric lines of growth.

Length, from front to posterior angle, thirty-one millimeters; height, from base to top of umbo, twenty-one millimeters.

Our examples are all natural casts, the shell-substance having in all cases been removed; but the characteristics of the species are so distinctive that it is recognized with little or no difficulty in that condition. It is a common species in the Upper Coal-Measures of Missouri, Illinois, Iowa, and Nebraska; Professor Swallow's type-specimens of the species having been obtained in the first-named State.

Position and locality.—Strata of the Carboniferous period; near Bear Spring, Camp Wingate, New Mexico.

GENUS ALLORISMA King, 1850.

Allorisma subcuneata (var.) Meek and Hayden.Plate XII, fig. 7 *a* and *b*.*Allorisma subcuneata* Meek and Hayden, 1858, Proc. Acad. Nat. Sci. Phila., 263.*Allorisma subcuneata* Meek and Hayden, 1864, Paleont. of the Upper Missouri, 37.

Shell of moderate size; outline clavate-cuneate as seen by either dorsal or ventral view, oblong-suboval as seen by side-view; posterior portion laterally compressed; anterior portion moderately gibbous; beaks depressed and placed about one-eighth of the length of the shell from the anterior extremity; posterior end abruptly rounded; anterior end narrowly rounded, somewhat prominent below and obliquely sloping above; basal margin straightened along the middle, but gently rounding before and behind to meet the anterior and posterior borders respectively; dorsal margin straight. Surface marked by distinct concentric undulations.

Length, about six centimeters; height, from base to cardinal border, twenty-eight millimeters.

Our specimens are in moderately good condition, but not entirely perfect, and, so far as they exhibit essential specific characters, they agree with those of *A. subcuneata*. They are, however, considerably smaller and rather less gibbous anteriorly than the type-specimens of Meek and Hayden are, and may possibly belong to a different species, yet I do not at present feel warranted in separating them from that species except as a variety. Typical examples of the species are somewhat common in the Upper Coal-Measure limestones of Missouri, Iowa, and Nebraska.

Position and locality.—Strata of the Carboniferous period; near Agua Azul, New Mexico.

CLASS GASTEROPODA.

SUBCLASS PROSOPOCEPHALA.

ORDER SOLENOCONCHA.

FAMILY DENTALIIDÆ.

GENUS DENTALIUM Linnæus, 1740.

Dentalium canna White.

Plate XII, fig. 6 *a* and *b*.

Dentalium canna White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 23.

Shell large, straight, or very slightly curved; transverse section circular or nearly so; test thin; surface marked by numerous, somewhat distinct, encircling lines of growth, crossed by fine, obscure, longitudinal striæ, the latter seen only upon well-preserved examples. Our specimens indicate that some individuals of the species reached a length of ten or twelve centimeters. The largest fragment measures a little more than nine millimeters in diameter at the base, and, at a distance of five and a half centimeters toward the apex, the diameter is six millimeters.

This species is distinguished for its large size in connection with the presence of encircling and longitudinal striæ. It resembles *D. priscum* Muenster from the Carboniferous rocks of Belgium, as described and figured by de Koninck in *Animaux fossiles du terrain de la Belgique*, but its apical angle is smaller, and the aperture is little if any oblique, while in that species the obliquity of the aperture is a distinguishing character.

Position and locality.—Strata of the Carboniferous period: near Salt Lake, New Mexico; and near Relief Spring, Arizona.

SUBCLASS DICEA.

ORDER RIIPHIDOGLOSSA.

SUBORDER DICRANOBRANCHIA.

FAMILY BELLEROPHONTIDÆ.

GENUS BELLEROPHON Montfort, 1808.

Bellerophon crassus Meek and Worthen.

Plate XII, fig. 1 a.

Bellerophon crassus Meek and Worthen, 1860, Proc. Acad. Nat. Sci. Phila., 458.*Bellerophon crassus* Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 335.

Shell large, massive, subglobose; volutions gradually expanding laterally, broadly rounded upon the back, more abruptly rounded at the sides and into the umbilici, which are rather small; outline of aperture reniform, its transverse diameter greatest; postero-lateral portions of the lip thickened and spread outward and backward over the inner volutions and also partly over the umbilici; antero-lateral portions of the lip thinner, their margins slightly convex on each side of the mesial notch; mesial band narrow, more or less distinct; mesial notch not deep.

Surface marked by distinct lines of growth, a part of which assume the character of somewhat irregular transverse wrinkles.

The collections contain only a single specimen of this well-marked species, which, although it measures thirty-eight millimeters across the aperture, is one-quarter smaller than one of the type-specimens used by Meek and Worthen in their description of the species.

The types were obtained from the Lower Coal-Measures of Illinois, and the species is also known to occur in the Upper Coal-Measures of Iowa and Missouri. So far as I am aware, it has not been found in the Lower Coal-Measures of the two last-named States.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, near Spring Mountain, Nevada.

SUBORDER PODOPHTHALMA.

FAMILY EUOMPHALIDÆ.

GENUS EUOMPHALUS Sowerby, 1815.

Euomphalus pernodosus Meek and Worthen.Plate XII, fig. 2 *a* and *b*.

Straparollus (Euomphalus) pernodosus Meek and Worthen, 1870, Proc. Acad. Nat. Sci. Phila., 45.

Straparollus (Euomphalus) pernodosus Meek and Worthen, 1873, Geol. Surv. Illinois, v, 604.

Shell rather above medium size when full grown, nearly discoidal, the spire being only very slightly elevated, and the inner portion of it being quite flat, or even slightly depressed; test thick; volutions five or six, the upper side flattened and sloping gently inward to the distinct suture, outer side flattened convex, under side rounding and sloping into the umbilicus; the angle formed by the upper and outer sides constituting a distinct carina, which is rugose or corrugated upon the outer volution; upon the under side of the volutions there is a row of moderately large, rounded nodes, separated by spaces of about their own width, those of the last half of the outer volution, and apparently those also of the two or three inner volutions, being obsolete; umbilicus moderately broad and deep, showing all the inner volutions.

Surface marked by striæ, distinct lines, and even ridges, of growth. None of the specimens in the collections are quite perfect, but their identity with *E. pernodosus* is unmistakable. The largest example measures about four and a half centimeters in diameter of coil. The types of the species measured one centimeter more. This well-marked species is comparatively rare, and, so far as I know, it has been found only at the locality which furnished the type-specimens and that from which those in the collections were obtained. The former were from the Lower Coal-Measures of Illinois.

It is quite distinct from every other species known to me, and may be easily recognized by its carina upon the outer side of the volutions above and its strong nodes below.

Position and locality.—Strata of the Carboniferous period; at the Mesa, Carrizo River, Arizona.

ORDER PECTINIBRANCHIATA.

SUBORDER TÆNIOGLOSSA.

FAMILY NATICIDÆ.

GENUS NATICOPSIS McCoy, 1844.

Naticopsis nana Meek and Worthen.Plate XII, fig. 4 *a* and *b*.*Naticopsis nana* Meek and Worthen, 1866, Geol. Surv. Illinois, ii, 365.

Shell small, subglobose, wider than high; spire much depressed; volutions about three, increasing very rapidly in size, last one large and ventricose; suture well defined; aperture large, broad-subovate, somewhat straightened at the inner side, its diameter nearly equal to seven-eighths of the entire axial length of the shell; outer lip thin; inner lip not much thickened; columella slightly flattened. Surface marked by fine lines of growth, which are a little stronger and more uniform on the upper side of the whorls, near the suture, than elsewhere.

Length, four millimeters; breadth, five millimeters.

Our examples of this little shell agree so exactly with the description and figures given by Meek and Worthen (*loc. cit.*) that I have given the foregoing description almost in the words of those authors.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, near Spring Mountain, Lincoln County, Nevada, where it was found associated with *Macrocheilus anguliferus* White.

FAMILY CAPULIDÆ.

GENUS PLATYCERAS Conrad, 1840.

Platyceras Nebrascense Meek.Plate XII, fig. 5 *a*, *b*, *c*, and *d*.*Platyceras Nebrascensis* Meek, 1872, U. S. Geol. Surv. Nebraska, 227.

Shell small, elongate-conical, strongly curved or subspiral; apex free, bluntly pointed, more or less curved toward the body, and turned to the dextral side of the shell; aperture irregularly oval; lip thin, broadly sinuous

behind to the left of the apex, remainder of the border having several other more or less indistinct sinuosities, with all of which the lines of growth upon the surface of the shell correspond.

All the specimens in the collections, and also those in my private collection, obtained from the same Upper Coal-Measure strata in Nebraska that supplied Mr. Meek with the types of the species, have the apex a little more curved than his type-specimen had, as may be seen by comparing the figures on Plate XII with his illustrations (*loc. cit.*). In other respects, our examples correspond with his figures and description, and I have little or no doubt of their specific identity with *P. Nebrascensis*.

Length, nineteen millimeters ; breadth, nine millimeters.

Position and locality.—Strata of the Carboniferous period ; near Santa Fé, New Mexico.

FAMILY MACROCHEILIDÆ.

GENUS MACROCHEILUS Phillips, 1841.

Macrocheilus anguliferus White.

Plate XII, fig. 3 *a*, *b*, *c*, *d*, *e*, and *f*.

Macrocheilus anguliferus White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 22.

Shell of medium size, irregularly rhombic in outline by side-view ; spire about equal in length to two-fifths the full axial length of the shell, acutely pointed ; volutions six or seven, increasing somewhat rapidly in size ; outer side of the volutions more or less convex, but the portion toward the apex is usually a little flattened ; posterior side narrow, usually squarely truncated, so as to form a distinct angle with the outer side. This angle is usually more or less prominent, but in some cases it is nearly obsolete, in which latter case the slight flattening of the posterior side merely produces the appearance of a deeply-impressed suture ; in the former case, there is a distinct, gradually-diminishing spiral shelf extending from the hinder part of the aperture to the apex ; aperture irregularly ovate, more or less truncated behind by the shelf referred to, effuse below ; outer lip sharp ; columella a little tortuous or nearly on a line with the axis of the shell. Surface apparently unmarked, except by the usual lines of growth.

Length of the largest specimen in the collection, thirty-six millimeters; width of the body-volution, twenty-three millimeters.

This shell varies considerably, especially in the distinctness of the angle and the convexity of the volutions; but it differs conspicuously from all other known species of *Macrocheilus* in the possession of such an angle at the posterior part of the whorls as has been described, or, in the absence of it, the somewhat deeply-impressed suture.

Position and locality.—Strata of the Carboniferous period; Camp Cottonwood, near Spring Mountain, Nevada.

CLASS CEPHALOPODA.

ORDER TETRABRANCHIATA.

FAMILY GONIATITIDÆ.

GENUS GONIATITES de Haan, 1825.

From Carboniferous strata upon the east side of Mount Nebo, Utah, a single, very imperfect specimen of *Goniatites* was obtained.* It is too imperfect for specific characterization; but yet its form and traces of the septa seem to indicate a difference from any known species. The shell is discoid; sides of the volutions slightly convex, the last one measuring at the aperture half as much as the full diameter across the whorls.

FAMILY NAUTILIDÆ.

GENUS NAUTILUS Breynius, 1732.

From strata of the Carboniferous period at the Mesa near Carrizo River, Arizona, some fragments of two species of *Nautilus* were obtained. One is probably identical with *N. latus* Meek and Worthen, the type-specimens of which were obtained from the Coal-Measures of Illinois. The other is either identical with, or closely allied to, *N. Springeri* White and St. John, the type of which species was obtained from the Upper Coal-Measures of Iowa.

CHAPTER VIII.

MESOZOIC AGE.

JURASSIC PERIOD.

RADIATA.

CLASS ECHINODERMATA.

ORDER CRINOIDEA.

FAMILY PENTACRINIDÆ.

GENUS PENTACRINUS Miller, 1821.

Pentacrinus asteriscus Meek and Hayden.Plate XIII, fig. 6 *a* and *b*.*Pentacrinus asteriscus* Meek and Hayden 1864, Paleont. Upper Missouri, 67.

This species was described by Meek and Hayden from fragments of the column and branches alone, which were collected from Jurassic strata at the southwest base of the Black Hills, North Platte River. They characterize the joints of the column thus:—"Rather small, thin, very symmetrical, pentagonal, star-shaped bodies, the rays of which are usually a little longer than wide, and somewhat acutely angular at their extremities. Through the center of each of these joints, there is a minute circular perforation, from which five lance-oval petaloid areas radiate, one to the extremity of each of the angles; the areas being bounded on each side by rather narrow, slightly-elevated, crenulate margins. This description applies more particularly to the largest-sized specimens, measuring about 0.18 inch from point to point of the opposite angles. Associated with these,

there are smaller joints, varying from 0.05 to 0.10 inch in diameter, having proportionally shorter and broader rays, which are usually less angular at the points than the broader ones are."

All the specimens of this species contained in the collections consist of portions of the column; and, up to the present time, nothing more has been learned concerning the characteristics of the species. Generally, these portions of the *Crinoidea* are of very little value in specific discriminations; but the characters of those parts of this species are so constant, even in examples collected at widely-separated localities, that it has been relied upon with considerable confidence in the identification of Jurassic strata. This is the only species of the genus *Pentacrinus* yet recognized in the Jurassic rocks of America, but it is not improbable that others may hereafter be discovered in them. The largest examples in the collections have a diameter one-third greater than that of the largest of those mentioned by Meek and Hayden, and they also present some slight variations from the latter. The principal difference is the alternation, at irregular intervals, of joints that are almost pentahedral with those that are deeply pentalobate. This character is shown in one of the figures on Plate XIII, but it is probably not a specific one.

Position and locality.—Strata of the Jurassic period: Salt Creek, near Nephi; and Diamond Valley, near Saint George, Utah. It has quite an extended geographical range, having been also discovered in Idaho.

MOLLUSCA.

CLASS CONCHIFERA.

ORDER MONOMYARIA.

FAMILY OSTREIDÆ.

GENUS OSTREA Linnæus, 1758.

Ostrea strigilecula White.

Plate XIII, fig. 3 *a*, *b*, *c*, and *d*.

Shell small, irregularly suboval in outline; axis much curved, making the ventral border broadly arcuate and the dorsal border more or less

irregularly concave; posterior margin rounded; hinge-line of moderate length. Right valve nearly flat or only very slightly convex; beak short; area narrow; ligamental groove small, shallow; muscular scar comparatively large, subcircular, situated nearly midlength of the valve, and nearer to the dorsal than to the ventral margin; internal face of the margins apparently not crenulated in any part. Left valve more capacious than the right; area small; ligamental groove small; an incipient alate expansion of the postero-dorsal portion is observable upon this valve, but not upon the other. Surface marked by the ordinary lines of growth, and also by a few very faint indications of radiating plications.

Length, twenty millimeters; breadth, fourteen millimeters.

The collections contain a few examples, of both right and left valves, in a good state of preservation, and they seem to represent a tolerably well-defined species of true *Ostrea*. The moderately large scar of attachment upon the beak of the left valve of our shell has somewhat distorted it; but there is no appearance of a curvature of the beak, such as is characteristic of the genus *Gryphea*.

The presence also of incipient plications upon the left valve, and of a ligamental groove, like that of *Ostrea*, upon its area, is also against the supposition that the shell belongs to the genus *Gryphea* rather than to *Ostrea*.

This species differs from the young of *O. Engelmanni* Meek and Hayden in being proportionally much longer and otherwise of different outline; the young of that species being broader than long, while ours is longer than broad, and has also the aspect of maturity.

Position and locality.—Strata of the Jurassic period; two miles south of Dirty Devil River, Utah.

FAMILY PECTINIDÆ.

GENUS CAMPTONECTES Meek (Agassiz), 1864.

Camptonectes stygius White.

Plate XIII, fig. 2 *a*, *b*, and *c*.

Camptonectes stygius White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 23.

Shell of moderate size, thin, lenticular; length of the hinge-line a little more than half the height of the shell from basal margin to beak; hinge-

line very slightly oblique with the axis of the shell, the latter inclining backward; but yet more than half the bulk of the shell is in front of it; the margin of the lower two-thirds of the shell is regularly rounded, the basal portion having rather a shorter curve than either the anterior or posterior portions.

Right valve apparently smooth, depressed-convex; posterior ear rather small, plain, its outer border forming a somewhat obtuse angle with the cardinal border; anterior ear moderately large, prominent, proportionally narrow; byssal notch deep, narrow, the upper and lower sides approaching each other at an acute angle; anterior border extending farther forward than the extremity of the anterior ear does; the border at the front is abruptly rounded and then continued backward and upward in an almost direct line to the bottom of the byssal notch. Surface apparently marked only by concentric striæ of growth, but, in a favorable light, indications of radiating striæ may be observed upon the best-preserved examples.

Height from base to beak, forty-one millimeters; breadth, forty millimeters; length of hinge, twenty-three millimeters.

This shell resembles *C. bellistriatus* Meek and Hayden from Jurassic strata of Dakota; but it differs in the outlines of the borders, the shape of the ears and of the byssal notch, and also in the surface-markings.

Position and locality.—Strata of the Jurassic period; east of Aquarius Plateau, fifteen to twenty miles south of Dirty Devil River, and also at the North Fork of Virgin River, Utah.

***Camptonectes bellistriatus* Meek and Hayden.**

Among the collections made at a locality of Jurassic strata, five miles east of Gunnison, Utah, some imperfect examples of *Camptonectes* were collected. They have the outlines and other characteristics, so far as they can be observed, of *C. bellistriatus* Meek and Hayden, and probably belong to that species.

FAMILY PTEREIDÆ.

GENUS INOCERAMUS Sowerby, 1814.

Inoceramus crassalatus White.Plate XIII, fig. 4 *a*, *b*, and *c*.

Shell rather small, thin; valves subequal, moderately convex, subovate or obscurely tetrahedral in marginal outline; hinge-line rather short, forming an angle with the axis of the shell of about seventy degrees; beaks small, not very prominent. Left valve more capacious than the right, having an indistinct auricular furrow extending from just behind the beak to the postero-basal border, obscurely defining a thick posterior wing; but the right valve has little or no trace of a similar furrow.

Surface of both valves marked by the usual lines of growth, and also by more or less numerous, slightly-raised, concentric folds.

Greatest length of an average example in the collection, about thirty millimeters; thickness, both valves together, about fifteen millimeters.

Position and locality.—Strata of the Jurassic period; North Fork of Virgin River, Utah.

ORDER DIMYARIA.

FAMILY TRIGONIIDÆ.

GENUS MYOPHORIA Bronn, 1830.

Myophoria ambilineata White.Plate XIII, fig. 5 *a* and *b*.

Shell subcircular or obscurely four-sided in outline, being very slightly longer than high, moderately gibbous; base broadly rounded; front regularly, but more shortly, rounded than the base; hinge-line of moderate length, straight or nearly so; posterior border, from the extremity of the hinge-line to the infero-posterior angle, nearly straight or slightly convex; infero-posterior angle sharply rounded; umbonal ridge passing to it from the beak with a slight curve, the convexity of which is toward the front; that ridge sometimes forming a slightly-raised but distinct carina.

Surface, both in front of, and behind, the umbonal ridge marked by

numerous, distinct, slightly-raised, concentric lines or narrow folds, which meet at nearly right angles at the umbonal ridge.

Height, about eight millimeters; length, eight and a half millimeters.

Position and locality.—Strata probably of the Jurassic period; Camp Cottonwood, old Mormon road, Nevada.

GENUS TRIGONIA Bruguière, 1789.

Trigonia ——— (?).

Associated with *Camptonectes bellistriatus* Meek and Hayden at a locality five miles east of Gunnison, Utah, some imperfect examples of a species of *Trigonia* of Jurassic type were found. They are too imperfect for specific recognition, but are noticed here in consequence of the value of the type in stratigraphic geology.

CLASS GASTEROPODA.

SUBCLASS DICECA.

ORDER RHIPHIDOGLÖSSA.

SUBORDER PODOPHTHALMA.

FAMILY NERITIDÆ.

GENUS NERITINA Lamarck, 1809.

Neritina? phaseolaris White.

Plate XIII, fig. 1 *a*, *b*, *c*, *d*, and *e*.

Neritina phaseolaris White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 24.

Shell small, obliquely suboval; volutions apparently from two and a half to three, the last one composing all but a very small part of that portion of the shell which is exposed to view; aperture obliquely ovate; character of the inner lip not clearly made out, but the shell has the external aspect of *Neritina*; a small elevated fold is usually seen at the suture upon the outer volution appressed against the next volution within. In some examples, the convexity of the outer volution, from the base of the small elevated fold above to the margin of the aperture below, is quite regular; but, in other

examples, this volution has a revolving rounded prominence, situated a little nearer the suture than the base, which causes a more or less conspicuous flattening of the outer side of the volution, as well as a slighter flattening of the space between that prominence and the suture. All the examples of this species in the collection having been preserved in a hard arenaceous limestone, all the characters of the inner lip could not be ascertained.

Surface marked by moderately distinct lines of growth, and sometimes faint indications of revolving striæ are also seen.

Greatest diameter of the largest example in the collection, thirteen millimeters; shorter diameter, ten millimeters; greatest height, lying with its aperture downward upon the table, eight millimeters.

While preparing the preliminary report (*loc. cit.*), I thought I had ascertained to a good degree the character of the inner lip, but subsequent examination still leaves the true character of it in doubt.

Position and locality.—Strata of the Jurassic period; Salt Creek, near Nephi, Utah, where it is associated with *Pentacrinus asteriscus* Meek and Hayden.

CHAPTER IX.

CRETACEOUS PERIOD.

MOLLUSCA.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

ORDER LYOPOMATA.

FAMILY LINGULIDÆ.

GENUS LINGULA Bruguière, 1792.

Lingula subspatula Hall and Meek.

Plate XV, fig. 4 a.

Lingula subspatula Hall and Meek, 1856, Mem. Amer. Acad. Arts & Sci., new series, v, 380.

Shell of ordinary size, somewhat oblong or semi-elliptical; postero-lateral margins gently convex to the posterior margin; lateral and antero-lateral margins nearly straight or only slightly curved, so that the shell is narrowed a little toward the front; front margin subtruncate. Surface marked by fine concentric striae and occasional gentle undulations.

Position and locality.—The type-specimens of the species were obtained by Hall and Meek from Cretaceous strata at “Red Cedar Island, thirty-five miles below Fort Pierre.” Those contained in the collections from which the foregoing description was drawn were obtained from strata of the same period, ten miles southeast of old Fort Wingate, New Mexico.

MOLLUSCA VERA.

CLASS CONCHIFERA.

ORDER MONOMYARIA.

FAMILY OSTREIDÆ.

GENUS OSTREA Linnæus, 1858.

Ostrea cortex Conrad.Plate XV, fig. 2 *a*, *b*, and *c*.*Ostrea cortex* Conrad, 1857, U. S. & Mex. Bound. Surv., i, 157.

Shell elongate, moderately capacious; test of mature examples thick; inferior valve much more capacious than the other, narrowing toward the apex, which is pointed and rather small; ligamental furrow long, moderately broad and deep, somewhat curved, its raised borders broadly rounded; upper valve corresponding with the lower, except that it is usually nearly flat transversely.

Surface of both valves marked by numerous strong, prominent, imbricating concentric laminae, which are sometimes laciniate, giving the shell a very rough appearance.

Length of the largest example in the collection, about one decimeter; breadth, nearly five centimeters.

Conrad's type-specimens of this species were obtained at "Dry Creek, Mexico," from strata the age of which was then unknown to him, because the collectors brought no associated species. Our collections, however, contain associated species that indicate unmistakably their Cretaceous age. Our examples show that the species is a very variable one; but they all present a certain facies that is quite characteristic, and which is expressed in the figures, both of Conrad's and this report. It is an interesting fact that the test in nearly all the examples of this species has been made completely porous by a species of *Cliona* or other burrowing sponge, while those of the following species are almost entirely unaffected by it. Possibly, however, the case of the last-named species is only a local exception.

Position and locality.—Strata of Cretaceous age; Colob Plateau, southwest of Kanara, and also at the North Fork of Virgin River, Utah.

Ostrea prudentia White.Plate XIV, fig. 2 *a, b, c, and d.*

Shell neat and symmetrical for a species of this genus, suboval or subcircular in outline when adult, subcircular when young, moderately capacious; beaks small, usually distinct, and approaching so near to each other when the valves are together as to leave only a narrow space between the areas. Lower valve moderately deep; area short and broad; ligamental groove short, broad, and distinct, bounded at each side by a rounded ridge; beak extending very slightly beyond that of the other valve; scar of attachment sometimes occupying one-quarter of the outer surface, sometimes extremely small, and sometimes apparently absent. Upper valve usually flat or a little concave transversely, but a little convex longitudinally in adult shells; area a very little shorter than that of the other valve, moderately convex or nearly flat.

Surface of both valves marked by distinct lines and laminae of growth, but this species is rather less laminated and roughened than is usual in the genus *Ostrea*. Somewhat numerous, corrugated, but rather indistinct radiating costae are usually to be seen on the ventral valve of young examples, yet these corrugations seldom or never extend to the front half of old shells.

Length, six centimeters; breadth, five centimeters.

This species is somewhat remarkable for its neatness of form and freedom from the crude extravagancies which species of this genus often exhibit.

Position and locality.—Strata of the Cretaceous period; east of Impracticable Ridge, Utah.

GENUS GRYPHEA Lamarck, 1801.

Gryphea Pitcheri var. Morton.Plate XVII, fig. 1 *a, b, c, d, e, and f.*

Gryphea Pitcheri Morton, 1834, Synop. Org. Remains, Cret. Group, 55.

Gryphea Pitcheri Römer, 1852, Kreidebildung von Texas, 73.

Gryphea Pitcheri Conrad, 1857, U. S. & Mex. Bound. Surv., i, 155.

Gryphea dilatata Marcou, 1858, Geol. North America, pl. iv, f. 2.

Shell reaching a moderately large size, very variable in shape, generally having an irregularly subovate marginal outline, often much longer than broad, but sometimes shorter than broad. Larger valve capacious, scaphoid, arcuate, more or less distinctly lobed, the posterior lobe occasionally somewhat wing-like; test rather thick; umbo large, prominent,

and incurved, or flattened and short; scar of attachment small or wanting; surface sometimes distinctly lamellose, but generally somewhat smooth, although marked by concentric lines of growth.

Upper valve nearly flat, moderately thick in the umbonal region; hinge-line well defined, straight; area distinct; ligamental groove small; inner surface smooth, more or less distinctly crenulated at the lateral edges; outer surface marked by numerous concentric, imbricating lines of growth, and sometimes also by faint, impressed, radiating striæ.

The collections contain numerous examples of this widely-known species, none of which, however, are of so large a size as are some of those figured by Rømer, Conrad, and others. In selecting examples for illustration, I have chosen representatives of two extremes of form from among others of all intermediate gradations. Mr. Conrad states (*loc. cit.*) that there are two distinct varietal types of this species, one of which resembles *G. vesicularis* Lamarck, and which was the typical form described and figured by Dr. Morton; and the other he designates as var. *navia*. The collections under examination, however, although they contain representatives of the two forms referred to by Mr. Conrad, seem to indicate no constancy of separate varietal characters, either of those forms or any others.

The largest specimens in the collections have a length of only about thirty-seven millimeters from the umbo to the basal margin, which is considerably less than that of some examples reported by other authors.

Position and locality.—Strata of the Cretaceous period:—twenty-five miles southeast of, and also near, Paria; East Fork of Paria Creek; east of Impracticable Ridge; Dirty Devil River, east of ridge, Utah: Cañon five miles west of Puerco; east of Mount Taylor; and Acoma Plateau, New Mexico, &c.

GENUS EXOGYRA Say, 1819.

Exogyra ponderosa Rømer.

Plate XIV, fig. 1 *a*, *b*, and *c*.

Exogyra ponderosa Roemer, 1852, Kreidebildung von Texas, 71.

Exogyra costata Conrad, 1857, U. S. & Mex. Bound. Surv., i, 154.

Shell large, capacious; marginal outline irregularly subovate; larger valve very gibbous; umbo distinctly spiral, but the coil is usually obscured

by a large scar of attachment; umbonal half obtusely carinate, the sides sloping abruptly from the carina to the margins; basal half not so deeply, but more regularly convex than the other. Test very massive, sometimes having a solid thickness of five or six centimeters, lamellose, so much so that the valve often splits into numerous pieces along the surfaces of the layers of growth; inner surface smooth; muscular scar of moderate size, somewhat deep, placed about midlength of the valve, and, as usual, a little nearer to the posterior than to the anterior side; surface marked by strong, irregular, imbricating lamellæ of growth, which become laciniate at and near the margins; surface also marked by fine concentric striæ, and by irregular, indistinct, radiating costæ, the latter being usually removed by exfoliation from old shells. The collections do not contain any example of the upper valve, but both Rømer and Conrad describe it as thick, concentrically laminated; smooth within; umbo horizontal, distinctly spiral.

Length of an example rather under the average size, from umbo to basal margin, about one decimeter; breadth, eight centimeters; convexity of the larger valve, nearly six centimeters.

Among the numerous examples of this species in the collections, none, except the one figured, show the radiating costæ, and these costæ seem to be quite different from those, at least of the typical forms, of *E. costata* Say. Mr. Conrad states, however, that in New Jersey, Alabama, and Texas every intermediate gradation of form and character is found, from typical forms of *E. costata* to *E. ponderosa*. Judging from our examples alone, no person would suspect such specific relationship; and, in want of any intermediate forms for personal examination, I prefer at present to place our examples under the designation given by Dr. Rømer.

Position and locality.—Strata of the Cretaceous period; east of Impracticable Ridge, Utah.

***Exogyra læviuscula* Rømer.**

Plate XVII, fig. 2 *a*, *b*, *c*, and *d*.

Exogyra læviuscula Rømer, 1852, Kreidebildung von Texas, 70.

Exogyra læviuscula Conrad, 1857, U. S. & Mex. Bound. Surv., i, 154.

Gryphea læviuscula Conrad, 1857, *ib.*, p. 170 and pl. vii.

Shell of moderate size, capacious, somewhat semi-ovate in form, sub-orbicular in marginal outline; test not massive; larger valve much inflated

and subhemispherical; a very indistinctly-defined umbonal ridge is to be seen upon some examples, especially near the beak, but in others this feature is wanting.

Umbo small, distinctly spiral, making about two volutions, sometimes nearly free, but often very closely curved, giving the posterior side an umbilicated character, sometimes having a very small scar of attachment, but often without such a scar, and always quite symmetrical, or at least not distorted, as the beak often is in other species of this genus; periphery of its curve usually extending beyond the hinge-line, but sometimes not. The smaller valve is nearly flat, or slightly and somewhat irregularly concave, suborbicular in outline. Surface of both valves having a smooth aspect, but it is marked with such lines of growth as are common to other genera of shells, and free from the lamination of surface so common in the *Ostreidae*.

Diameter of the largest example in the collection, from umbo to basal margin, forty-seven millimeters; transverse diameter, forty-two millimeters; depth of the larger valve, twenty-eight millimeters.

The collections contain numerous examples of this species, the type-specimens of which were obtained by Dr. Rømer from near San Antonio, Texas. The figure given by Dr. Rømer (*loc. cit.*) represents the umbo of the larger valve more nearly free than that of any of our examples is; the umbo in all our examples being closely incurved. In this respect, ours are more nearly like those figured and described by Conrad.

Position and locality.—Strata of the Cretaceous period; Linear Plateau, Southeastern Utah.

***Exogyra costata* Say, var. *fluminis*.**

Plate XVII, fig. 3 *a*, *b*, *c*, and *d*.

Shell rather small, irregularly ovate in outline, somewhat expanded. The larger valve moderately capacious; greatest convexity near the middle, from which part the sides slope with less convexity to the basal and lateral margins; an obtuse, indistinct carina generally appears upon the umbo, becomes obsolete as it extends, and finally disappears about the middle of the valve; umbo small, depressed, distinctly spiral; volutions two or less; a scar of attachment usually obscures the inner volution, but seldom or

never distorts the beak or impairs its symmetry. Smaller valve nearly flat or slightly concave, suborbicular in outline. Surface of the smaller valve marked by numerous thin imbricating striæ of growth; that of the larger valve marked by numerous small radiating costæ, which are quite distinct upon the umbonal region, but become obsolete or absent upon the basal portion of the valve. These costæ are slightly crenulate or irregular, increase a little in size from the umbo toward the base, increase in number both by intercalation and bifurcation, and occupy only the external layers of the test, exfoliated surfaces being free from them.

Diameter, from umbo to basal margin, of the largest example in the collection, forty-two millimeters; transverse diameter, thirty-four millimeters; convexity of the larger valve, nineteen millimeters.

This shell reaches a size nearly equal to that of *E. læviuscula* Rømer; but it is distinguished from that species by the costate surface, less convexity, and smaller umbo of the larger valve.

From the typical forms of *E. costata* Say, as they are identified from the Cretaceous strata of New Jersey, Alabama, and Texas, it differs in its much smaller size, its thinner and more delicate test, and proportionally smaller costæ. The collections contain numerous examples of this variety, but none of the typical forms of *E. costata*. Some of the examples are very young, but the usual uniformity of size prevails among the larger ones that indicates adult age, and they have also the aspect of maturity. If it were not for the well-known tendency to extreme variation among the *Ostreidæ*, I should not hesitate to separate this as a distinct species rather than as a variety. It is not improbable that, when full and careful comparisons shall have been made, our shell will be found specifically distinct from *E. costata*. In such a case, I propose the varietal name given above for a specific one.

Position and locality.—Strata of the Cretaceous period; east bank of the Rio Puerco, six miles below Casa Salazan, New Mexico.

FAMILY PECTINIDÆ.

GENUS CAMPTONECTES Meek (Agassiz), 1864.

Camptonectes platessa White.

Plate XVII, fig. 5 a.

Camptonectes platessa White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 25.

Shell thin, suborbicular in outline; length of hinge-line about equal to one-half the transverse diameter; ears well defined by auricular furrows; posterior ear short, flat, its outer margin slightly concave; anterior ear moderately large, marked by distinct lines of growth and obscure radiating striæ. The anterior ear of the right valve separated from the body-portion by a deep, rather narrow, and somewhat angular sinus, the depth of which is equal to about one-half the length of the ear from its outer extremity to the beak. Radiating striæ of the surface moderately fine, increasing in number so rapidly that the direction of the outer ends of those above the middle of the valve is transverse, and farther toward the hinge they are distinctly recurving; the radiating lines crossed by fine concentric striæ, and occasionally by more distinct lines of growth.

Height and transverse diameter each about forty-five millimeters.

This species somewhat resembles *C. bellistriata* Meek and Hayden from the Jurassic strata of Dakota; but it is proportionally not so broad from front to rear, the ears are proportionally a little longer, and the radiating striæ a little coarser.

Position and locality.—Strata of the Cretaceous period; fifty miles north of Camp Apache, and five miles west of Mineral Spring, Arizona.

FAMILY LIMIDÆ.

GENUS LIMA Bruguière, 1791.

Lima Wacoensis Römer.

Plate XVII, fig. 4 a, b, and c.

Lima Wacoensis Römer, 1852, Kreidebildung von Texas, 63.*Lima Wacoensis* Conrad, 1857, U. S. & Mex. Bound. Surv., i, 151.

Shell rather small, moderately convex, oblique, irregularly oval in marginal outline; antero-basal margin broadly rounded; posterior margin

regularly but more shortly rounded than the base; front margin subtruncate; postero-dorsal margin nearly straight or slightly convex, and nearly parallel with the antero-basal margin; hinge short; ears of about equal size, small, but distinct, each forming an obtuse angle by the cardinal border, and the anterior and posterior borders respectively; beaks small, distinctly defined, projecting a very little over the cardinal border. Surface marked by numerous radiating costæ, which have interspaces of similar or slightly greater width between them; costæ becoming smaller upon each side of the umbonal region, and absent from the ears.

The long diameter of the largest example contained in the collections is about seventeen millimeters; short diameter, fourteen millimeters.

This beautiful and well-marked species has quite a wide geographical range. It was originally discovered by Roemer in the Cretaceous strata of the valley of the Guadalupe, near New Braunfels, Texas.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

FAMILY PTERIIDÆ.

GENUS INOCERAMUS Sowerby, 1814.

Inoceramus problematicus Schlotheim, *sp.*

Plate XVI, fig. 3 *a.*

Mytilus problematicus Schlotheim, 1820, Petrefact., 312.

Mytilus labiatus Brongniart, 1822, Geol. des Envir. Paris, 215.

Inoceramus mytiloides Goldfuss, 1836, Petrefact. Germ., 118.

Inoceramus problematicus d'Orbigny, 1843, Pal. Française, iii, 510.

Inoceramus mytiloides Roemer, 1852, Kreidebildung von Texas, 60.

Shell oblique, elongate-ovate in marginal outline, moderately inflated in its anterior and umbonal portions, but somewhat compressed posteriorly; valves subequal; left valve more capacious than the right; umbones oblique; beaks small, pointing forward and incurved, reaching a little farther forward than the anterior border; front side broadly rounded, and nearly parallel with the posterior side; each valve, for a short distance below the beaks, bent abruptly inward to the margin; postero-basal margin abruptly rounded; posterior or anal side broadly rounded to the cardinal border; hinge comparatively short.

Surface marked by moderately strong concentric plications, and also by fine concentric lines of growth.

The dimensions of this shell differ much with age in their relative proportions; the older ones being proportionally much more elongate than the young ones. This is due to the more rapid growth of the shell in and near the postero-lateral region than elsewhere. The long diameter of one of our examples is a little more than six centimeters; the short diameter about three and a half centimeters.

This is perhaps one of the most widely-distributed species of the genus in the Cretaceous strata of the United States, and also perhaps one of the most variable. This, together with the fact that no species of *Inoceramus* possesses very salient specific characters, often renders its identification a matter of some difficulty, especially if the specimens are imperfect. There seems, however, to be very little reason for doubting that the forms under examination belong to the species *I. problematicus*, as originally described by Schlotheim.

Position and locality.—Strata of the Cretaceous period: southeast of Paria, Utah; and also upon the West Fork of Paria Creek, Utah.

***Inoceramus fragilis* Hall and Meek.**

Plate XV, fig. 3 *a*.

Inoceramus fragilis Hall and Meek, 1856, Mem. Am. Acad. Arts & Sci., n. s., v, 388.

Shell of medium size, obliquely ovate in marginal outline, somewhat inflated; beaks small, pointed, turned forward; hinge-line rather long; surface marked by concentric undulations and fine lines of growth, but the shell has a somewhat smooth aspect.

The collections contain only a single example of this species, which has been recognized by Mr. Meek as identical with *I. fragilis*.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

***Inoceramus flaccidus* White.**

Plate XVI, fig. 1 *a* and *b*.

Shell large, irregularly subovate in marginal outline, exclusive of the ears; valves subequal, not much inflated; wing moderately large, well defined at its inner side by an auricular furrow; hinge-line not very long, nearly

at right angles with the front of the shell, and only a little oblique with the axis; a more or less distinct, but somewhat irregular, furrow extending the whole length of the shell from the posterior side of the umbo to the postero-basal margin, giving each valve an obscurely-bilobed appearance; crenulated face of the hinge narrow, crenulations small; umbonal region narrow; beaks prominent, curved forward and inward; test comparatively thin throughout the whole shell; surface having the ordinary concentric lines of growth, and the test is also thrown into numerous rude and irregular concentric undulations.

Length of the largest example in the collection, about twenty-two centimeters; greatest breadth, about fifteen centimeters.

This species is remarkable for the rudeness and extravagant irregularity of the undulations of the surface, of which irregularity the outline also partakes, giving the shell a flaccid aspect. The specimens of the collections are almost wholly in the form of natural casts, being preserved in a fine-grained calcareous sandstone, some of which is crowded with fragments of this species.

Position and locality.—Strata of the Cretaceous period; five miles above Pueblo, Colorado.

***Inoceramus deformis* Meek.**

Plate XV, fig. 1 *a* and *b*.

Inoceramus deformis Meek, 1872, Geol. Surv. Wyoming & Contiguous Territories, 296.
Inoceramus deformis Meek, 1874, (Manuscript) U. S. Geol. Expl. 40th Parallel.

Shell moderately large, irregularly subovate or subcircular in marginal outline; entire form subglobose when adult; valves subequal, very much inflated; beaks broad, not very prominent; hinge-line short; cardinal border of test somewhat massive; crenulated face of the hinge moderately broad; test thin in the middle region of the valves, but it becomes greatly thickened at the margin of old shells, in some cases forming a massive rim around the whole border of each valve, including the cardinal border.

Surface marked by the ordinary fine concentric lines of growth, and the test is also thrown into more or less regular, coarse, concentric folds or undulations.

Diameter of the largest example in the collections, measured along the

axis of the shell, nearly sixteen centimeters; breadth of the same at right angles with the former measurement, about fourteen centimeters; thickness, both valves together, not far from fourteen centimeters.

This species is remarkable for its extreme gibbosity, and the great thickening of the test at the borders of the valves. Disconnected fragments of these thickened valves are often met with, which has led to the supposition that they indicated a species, perfect examples of which were not yet discovered, and which was provided with a test equally thick throughout. The relative thickness of the test, however, in different parts of the valve, is shown at least approximately in figure 1 *b*, Plate XV.

The test of all the known examples of this species, as is usually found to be the case with the test of *Inoceramus*, has wholly a prismatic structure, and is much thinner in the middle and umbonal regions than toward the free borders, while the reverse is usually the case with conchifers. This seems to indicate that a portion of the thickness of the valve at the middle and umbonal region was absorbed while the animal was alive, or that a thin pearly layer was originally formed upon the inside of the valves, as in *Pinna*, and that it became dissolved or decomposed after its entombment, by agencies which the prismatic layer resisted. The latter suggestion is strengthened by the fact that many of the Cretaceous *Pinnas* show no trace of a pearly layer, such as living *Pinnas* have, while the prismatic layer is well preserved. It is difficult, however, to reconcile this with the fact that the pearly layer in *I. Barabini* is often as well or better preserved than the prismatic layer.

Position and locality.—Strata of the Cretaceous period; five miles above Pueblo, Colorado.

Inoceramus Barabini Morton.

Plate XVI, fig. 4 *a*.

Inoceramus Barabini Morton, 1834, Synop. Org. Remains Cret. Group, 62.

? *Inoceramus Crispii* Conrad, 1857, U. S. & Mex. Bound. Surv., i, 152 (not Mantell).

Shell of medium size, elongate-ovate in marginal outline, moderately inflated, especially in front and in the umbonal regions; valves equal, or nearly so; umbones more or less inflated; beaks small, not reaching quite so far forward as the front side of the shell; front truncated and short; basal margin broadly rounded; posterior margin curving somewhat abruptly

upward from the base and rounded to the cardinal margin ; hinge-line long, sometimes nearly parallel with the basal border, and never much divergent from it.

Surface marked by moderately strong folds or undulations, and also by fine lines of growth.

Long diameter, of an average-sized example, about seven centimeters ; shorter diameter, at right angles with the former measurement, four and a half centimeters.

The conspicuous features of this species are its long, slightly divergent hinge-line, and its inflated truncated front.

It is a fact worthy of note that the greater part of the examples of this species in the collections have the pearly layer of the test in a better state of preservation than the prismatic layer, while in the numerous other species of the genus that have come under my observation, the pearly layer is usually, if not always, wanting.

Position and locality.—Strata of the Cretaceous period; one and a quarter miles south of Boulder, Colorado, and at Gallinas Creek, New Mexico.

Inoceramus dimidius White.

Plate XVI, fig. 2 *a*, *b*, *c*, and *d*.

Inoceramus dimidius White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 25.

Shell very small for one of this genus, inflated, sometimes much so, obliquely subovate in outline ; valves subequal, the left one being a very little more capacious than the other ; test thin ; beaks small, prominent, acute, incurving, and pointing a very little forward ; hinge-line straight or nearly so, rather short.

Surface marked by more or less regular and more or less strong concentric folds or undulations. In some cases, these undulations continued to be formed only until the shell had attained about half its full size, when they ceased, the remainder of the surface being marked only by ordinary concentric lines of growth. This irregularity in the formation of concentric folds is sometimes connected with considerable distortion of the usual symmetry of the shell.

The long diameter of an average example from the umbo to the postero-

ventral margin, twenty-six millimeters; greatest breadth, eighteen millimeters; thickness, sixteen millimeters.

This species is especially distinguished by its small size. Its other more conspicuous specific characters are the small but prominent and pointed beaks and subequal valves. From the young of *I. problematicus*, the valves of which are also subequal, it differs in the character of the beaks just mentioned, the much greater convexity of the valves, and other evidences of mature growth.

The collections contain quite a large number of examples of this neat little species, both valves of which, in a majority of cases, are together in their natural position.

Position and locality.—Strata of the Cretaceous period; Ojo del Piscado, New Mexico.

FAMILY PINNIDÆ.

GENUS PINNA Linnæus, 1758.

Pinna petrina White.

Plate XIII, fig. 7 *a* and *b*.

Pinna petrina White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 24.

Shell moderately large, broad, rather thick, rapidly expanding in height as it increases in length; dorsal margin concave; ventral margin convex; a more or less strongly-raised carina extending from the beak to the posterior margin, defining a prominent longitudinal angle along the median portion of each valve, which is placed a little nearer the ventral than the dorsal border; transverse section rhomboidal, the sides of the rhomb being slightly convex; posterior margin oblique with the axis of the shell, forming a distinct but obtuse angle with the dorsal margin. The acute angle which it would form with the ventral margin if continued all the way to it in a direct course is abruptly rounded.

Surface marked by strong, distinct lines of growth, which run obliquely downward and backward in a nearly direct course from the dorsal margin, across the mesial angle, to near the ventral margin, where they are abruptly flexed forward, and blend with the ventral border. Crossing the lines of growth upon the surface above the mesial angle, there are coarse but indis-

tinct radiating striæ, and occasionally still more indistinct traces of similar ones below that angle, all of which are more discernible upon the anterior than upon the posterior part of the shell. More or less of the test is preserved upon all the specimens; but no trace of the pearly layer has been detected, all the test having the usual prismatic structure.

Some of the largest examples measure seven and a half centimeters in width along the posterior margin, and they must have been not less than seventeen centimeters in length when entire. The large size, proportionally great width, and angular aspect of this shell distinguish it from any other likely to be confounded with it. It resembles *P. Renauxiana* d'Orbigny, as figured by him in *Paléontologie Française*, but it expands much more rapidly in width than that species does, is not proportionally so thick, and has a very different posterior marginal outline. In that shell it is the middle of the posterior margin that is most extended, while in ours the greatest extension is much below the middle.

Position and locality.—Strata of the Cretaceous period; east of Mount Taylor, one mile south of Pajuate, New Mexico.

ORDER DYMYARIA.

FAMILY ARCIDÆ.

GENUS IDONEARCA Conrad, 1862.

Idonearca depressa White.

Plate XVIII, fig. 13 *a* and *b*.

Shell of moderate size, gibbous, irregularly trapezoidal or subovate in marginal outline; posterior half of the basal margin nearly straight, broadly rounding upward anteriorly, and sharply rounding the end of the umbonal ridge to meet the posterior margin; anterior margin regularly rounded up to the hinge-line; posterior margin long, about equal in length to the full height of the shell, nearly straight or slightly convex, extending obliquely downward and backward; hinge-line equal to a little more than half the length of the shell; areas small, narrow, well defined, slightly concave; beaks very small, depressed, a little incurved; umbonal ridges very prominent, each bounding anteriorly a flattened, three-sided space, along the middle of which there is a radiating, raised line.

Surface marked by the usual lines of growth and also by numerous small, flat, radiating costæ of unequal width, with narrow, sharply-impressed interspaces between them; costæ largest upon and near the umbonal ridge, becoming obsolete near the cardinal border, both anteriorly and posteriorly.

Length, measuring across at about midheight of the shell, twenty-eight millimeters; height, from base to umbo, twenty-three millimeters; thickness, both valves together, about twenty millimeters.

This species is not fully represented in the collections, but its specific characters are very satisfactorily shown. A full collection of examples would probably show variations of outline, due to sex, in some cases, whereby the aspect of the shell may be a little different from that of the figure. It is perhaps as nearly related to *I. Shumardi* Meek and Hayden as to any other described species, but it is clearly distinguished from that by its depressed beaks and prominent umbonal ridges.

Position and locality.—Strata of the Cretaceous period; east bank of Rio Puerco, six miles below Casa Salazan, New Mexico.

FAMILY LUCINIDÆ.

GENUS LUCINA Brugnière, 1792.

Lucina subundata Hall and Meek.

Plate XVIII, fig. 12 *a*.

Lucina subundata Hall and Meek, 1856, Mem. Am. Acad. Arts & Sci., n. s., v, 382.

Shell suborbicular in marginal outline, lenticular, moderately convex, length a little greater than the height; basal margin broadly rounded; anterior and posterior margins a little more narrowly rounded than the base; postero-dorsal margin gently sloping; beak small, slightly elevated, a trifle nearer to the posterior than to the anterior side. Surface marked by the ordinary concentric lines of growth, which are crossed by very faint radiating striæ.

Length, fifteen millimeters; height, thirteen millimeters.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

FAMILY GLOSSIDÆ.

GENUS VENIELLA Stoliczka, 1870.

Veniella goniophora Meek.*Veniella goniophora* Meek, 1875, Paleont. Upper Missouri River, 152.

Some imperfect examples of this species were obtained from Cretaceous strata southeast of Paria, Utah. Mr. Meek's types of the species were obtained from the valley of the Missouri River, near Fort Benton. The above-named work, which is now issuing from the press, contains full descriptions and illustrations, for which the examples in hand are too imperfect to furnish a satisfactory basis.

FAMILY MACTRIDÆ.

GENUS MACTRA Linnaeus.

Mactra? incompta White.Plate XVII, fig. 6 *a* and *b*.

Shell small, transversely subovate in marginal outline; valves moderately convex; beaks somewhat prominent, placed a little more than one-third the length of the shell from the front; dorsal border strongly arching; base broadly rounded; front regularly but strongly rounded; posterior border broadly rounded down to the basal margin, which it meets at an obtuse angle, and which is there met by an obscure, broadly-curving umbo-nal ridge. Surface marked by somewhat regular, small but distinct, raised, concentric striae. The general aspect of the shell, the absence of an external ligament, and the presence of a well-developed lateral tooth in the left valve (all of the hinge yet seen) suggest its reference to the genus *Mactra*, but it may probably be found to differ from the typical forms of that genus by the discovery of the whole hinge.

Length, eighteen millimeters; height, from beaks to base, fourteen millimeters; thickness, nine millimeters.

Position and locality.—Strata of the Cretaceous period; five miles above Pueblo, Colorado.

FAMILY ANATINIDÆ.

GENUS LEIOPISTHA Meek, 1864.

SUBGENUS PSILOMYA Meek (manuscript, 1874).

Leiopistha (Psilomya) Meekii White.Plate XVIII, fig. 14 *a*, *b*, *c*, and *d*.*Leiopistha (Psilomya) Meekii* White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 26.

Shell short, much inflated; umbones large, elevated; beaks small, strongly curved inward and downward, and very slightly turned forward; posterior portion moderately produced, somewhat compressed laterally; free margins forming a regular but unequally convex curve, the greatest convexity of which is in front and the least along the base; upper portion of the posterior border obliquely truncated, so that the greatest posterior extension of the shell is a little below the hinge-extremity.

Surface having a smooth aspect, but it is marked by fine concentric lines of growth. Under a lens, very fine, obscure, radiating striæ are seen upon the surface of a little more than the anterior half of the shell; and upon the remainder of the surface, except a small space adjoining the posterior cardinal border, there are small, somewhat distant, radiating striæ, easily seen by the unassisted eye. Upon these striæ, both the distinct and obscure, the lens shows numerous minute punctures, placed at irregular intervals, which are the bases of minute, short, blunt spines, or which mark the places from which the spines have been removed.

Length, twenty-five millimeters; height, from base to umbo, twenty millimeters; greatest thickness, both valves together, sixteen millimeters.

This shell seems to be more nearly related to *L. globosa* (= *Poromya globosa* Forbes) than to any other described species. Compared with that species, as figured and described by Stoliczka (Cretaceous Fauna of Southern India, vol. iii, p. 47, pl. iii, fig. 8, and pl. xvi, fig. 16), ours differs in being less globular, in having the umbones more elevated, and in the more distinct radiating striæ upon the posterior half of each valve.

This species belongs to an interesting group of shells, which form a part of the family *Anatinidæ*, and which Mr. F. B. Meek has defined under

the generic name of *Leiopistha*, of which genus he regards the *Cardium elegantulum* of Roemer as the type. He has also divided the genus into three sections or subgenera, under the names of *Leiopistha* proper, *Cymella* and *Psilomya* (the latter yet in manuscript and awaiting publication). The species here described is regarded as a typical one of the last-named subgenus. The completeness and precision with which that distinguished paleontologist has done the work upon this group of shells reflect great credit upon the science, and it affords me pleasure to name this species in his honor.

Position and locality.—Strata of Cretaceous age; southeast of Paria, Utah.

SUBGENUS CYMELLA Meek, 1864.

Leiopistha (*Cymella*) *undata* Meek and Hayden, *sp.*

Plate XVIII, fig. 15 *a*.

Pholadomya undata Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 81.

Cymella undata Meek, 1864, Smithsonian Check-List Cret. and Jurassic Fossils, 34.

Shell small, subovate in marginal outline; valves moderately convex; beaks somewhat prominent, incurving, and very slightly turned forward, placed about two-fifths the length of the shell from the front; front margin regularly, and basal margin more broadly, rounded; dorsal margin sloping a little downward to the front and behind, sloping gently to the posterior margin; the latter margin regularly, but a little more abruptly, rounded than the front; concentric undulations comparatively strong and distinct, all around, parallel with the free margins; radiating impressed lines of the middle of the valves also distinct, but rapidly diminishing in distinctness toward both ends; a narrow fold extends from beneath the beak, along the postero-dorsal region, producing a narrow furrow along the lower side of the fold, and a similar but less distinct one between it and the dorsal border, both furrows being of about the same width as the fold.

Length, thirteen millimeters; height, from beak to base, nearly ten millimeters.

This species is the type of the subgenus *Cymella*.

Position and locality.—Strata of the Cretaceous period; Gallinas Creek, New Mexico.

FAMILY CORBULIDÆ.

GENUS CORBULA Bruguière, 1792.

Corbula nematophora Meek.Plate XVII, fig. 7 *a*, *b*, and *c*.*Corbula nematophora* Meek, 1872, Geol. Surv. Montana, Idabo, Wyoming, and Utah, 496.

Shell small, subovate or subtetrahedral in marginal outline, nearly equivalve, moderately gibbous, height in relation to the length about as seven to ten, posterior extremity somewhat produced; basal margin broadly rounded, abruptly rounded up at each end to meet the anterior and posterior slopes respectively; anterior slope more abrupt than the posterior, almost straight or slightly concave; posterior slope longer and more oblique than the anterior, nearly straight; umbones rather prominent; beaks small, slightly incurved; umbonal ridge somewhat distinct; postero-dorsal region flattened and sometimes marked by an inconspicuous radiating raised line.

Surface marked by fine, raised, concentric lines of growth, and also by strong, concentric folds placed at irregular intervals, having apparently been produced by the temporarily arrested marginal growth of the shell at irregular intervals of time. Sometimes the surface, especially that of the left valve, is nearly free from these folds, but in other cases they are so distinct as to produce considerable distortion of the valve.

Length, six millimeters; height, four millimeters.

The average size of the specimens contained in the collections is considerably less than that given by Mr. Meek (*loc. cit.*) for his largest typical example; but there seems to be very little reason to doubt that the shells under examination are specifically identical with *C. nematophora*.

The average size of the specimens obtained at the second locality named below is greater than that of those obtained from the first-named locality. This is probably due to the difference in the conditions of the habitat of the mollusks at the two localities respectively, while they lived, as indicated by the composition of the rock in which they are now embedded; that of the first-named locality being comparatively pure limestone,

while the rock of the other locality is soft, clayey shale, with thin intercalated layers of impure limestone.

Position and locality.—Strata of the Cretaceous period; plateau near the west crossing of the North Fork of Virgin River, and elsewhere near the North Fork of that river, Utah.

CLASS GASTEROPODA.

SUBCLASS DIŒCA.

ORDER RHIPHIDOGLOSSA.

SUBORDER PODOPHTHALMA.

FAMILY NERITIDÆ.

GENUS NERITINA Lamarck, 1809.

SUBGENUS VELATELLA Meek, 1872.

Neritina (*Velatella*) *carditoides* Meek.

Plate XVIII, fig. 7 *a*, *b*, and *c*.

Neritina (*Dostia*?) *carditoides* Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 499.

Shell of medium size, broadly oval in marginal outline, depressed-convex; apex subspiral, slightly oblique, reaching nearly to the posterior margin, and depressed nearly upon the posterior border; inner lip occupying a little more than half the under surface of the shell, smooth, slightly convex, apparently thick, but really thinned by absorption within; the free margin of the inner lip somewhat sharp, straight, plain; outer lip thickened, coarsely and somewhat obscurely crenulate; aperture subreniform, considerably less in size than one-half the under surface of the shell. The space between the shelf-like inner lip and the roof of the shell is partially divided by a thin, slightly-twisted process or vertical partition, which extends inward and backward from the antero-dextral corner directly toward, but not reaching, the apex, so that communication between the two portions of the space thus partially divided was around the posterior edge of the partition.

Surface marked by fifteen or twenty radiating costæ similar to those that mark *Cardium* or *Cardita*, and these are crossed by numerous distinct lines of growth.

Mr. Meek described this species from Cretaceous strata at Coalville, Utah, together with *N. bellatula*, another species possessing similar sub-generic characters, to designate which he proposed the subgeneric name of *Velatella*.

Position and locality.—Strata of the Cretaceous period; south of Last Bluff, Utah.

ORDER PECTINIBRANCHIATA.

SUBORDER TÆNIOGLOSSA.

FAMILY APORRHAIIDÆ.

GENUS ANCHURA Conrad, 1860.

Anchura ? fusiformis Meek.

Plate XVIII, fig. 4 a.

Anchura ? fusiformis Meek, 1874 (Manuscript), Geol. Expl. 40th Parallel.

Shell of medium size; body subfusiform; spire somewhat elongated and tapering to a point; volutions eight or nine, convex; suture impressed; last volution moderately large, without a revolving angle. Wing moderately large, broad-oblong; outer border nearly straight and nearly parallel with a line produced from the slope of the opposite side of the spire; its posterior end terminating in a somewhat slender, slightly curved, sharp, backward-projecting spine-like process; its anterior end terminating in a somewhat distinct, but obtuse, angle; posterior border of the wing having a somewhat regular concave curve between the base of the spine-like process and the spire; anterior border of the wing curving with slight irregularity from the anterior angle of the outer border to the anterior canal; this canal is moderately long and slender.

Test thin and delicate, except at the borders of the wing, where it is considerably thickened, and there are also some indications upon one of our examples of a thickening of the posterior end of the inner lip.

Surface marked by fine, distinct striæ and numerous, somewhat irregular undulations of growth. Crossing these striæ of growth, the surface is covered with minute revolving striæ of uniform size, giving it a delicately-ornamented appearance under the lens. Upon some of our examples, however, the

revolving striæ are obsolete. Occasionally also a few incipient vertical costæ are to be seen upon the body volution of large specimens.

Length of the largest example in the collection, from the apex of the spire to the end of the anterior canal, thirty millimeters.

Mr. Meek's type-specimens being incomplete, he was in doubt whether they ought to be referred to the genus *Anchura* or not. The examples under consideration will not enable me to decide the question now. The presence of a little callus preserved at the posterior portion of the aperture of one of our examples suggests the probable presence of a posterior canal; in which case the shell cannot be assigned to *Anchura*, but probably belongs to the genus *Helicaulax* Gabb.

Position and locality.—Strata of the Cretaceous period: east bank of Rio Puerco, six miles below Casa Salazan; six miles west of Seboetto; and Cerro Rotunda, New Mexico.

GENUS LISPODESTHES, *nov. gen.*

Etym.—*λίσπος*, smooth, and *ἔσθης*, a garment; in allusion to the callus-covered spire.

Shell fusiform; anterior canal straight or slightly curved, and more or less produced; posterior canal extending nearly or quite the whole length of the spire, from near the apex of which it may be a little deflected; aperture winged; wing rather large, bearing two processes; the posterior process spine-like or falciform; the anterior process either in the form of a lobe or tongue-shaped; inner lip and spire covered with callus.

This genus is related to *Helicaulax* Gabb, and may possibly prove to be only subgenerically distinct from it. It differs from that genus in having the callus enveloping the whole spire instead of extending along the under side only, and also in the presence of the moderately large anterior process of the wing. In some respects it is like *Calyptraphorus* Conrad, but it differs conspicuously from that genus in having two prominent processes to the wing instead of being plain, thickened, rounded, and smooth. Besides this, the form is not so elongate as is common in that genus.

Only two species of this genus, so far as I am aware, have been discovered in the Cretaceous strata of North America, both of which are described in this report.

Lispodesthes nuptialis White.Plate XVIII, fig. 3 *a* and *b*.

Anchura nuptialis White, 1874, Exp. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 24.

Shell small; body subfusiform; wing moderately large; spire somewhat prominent, acute, but so thickly encrusted with callus that the volutions are only obscurely shown, except where the callus is removed by exfoliation; revolving angle absent or obsolete upon the volutions of the spire, even when bared by exfoliation of the callus, but it is somewhat distinct upon the body-volution, being continued out upon the falciform process of the wing. This posterior falciform process diverges widely from the axis of the shell, but, by recurving, it extends nearly as far backward as the apex of the spire; anterior process of the wing somewhat thickened, its breadth throughout about equal to that of the falciform process at the base, its length and breadth about equal, its outer end obliquely rounded; space between the two processes very narrow; from the base of the anterior process the border of the wing extends forward with a concave curve to the base of, and ends at, the long, slender anterior canal; posterior border of the wing concave and continuous with that of the falciform process on the one hand, and with the callus-border of the posterior canal on the other.

Length, from the apex of the spire to the end of the anterior canal, twenty millimeters; breadth, measuring across from the base of the processes of the wing to the opposite side, nine millimeters; spire, falciform process, and anterior canal, each about seven millimeters.

Position and locality.—Strata of the Cretaceous period; fifty miles north of Camp Apache, five miles west of Mineral Spring, Arizona.

Lispodesthes lingulifera White.Plate XVIII, fig. 2 *a* and *b*.

Shell rather small; body subfusiform; wing moderately large; spire of medium size, acute, nearly or wholly encrusted with callus, by which the form of the volutions is obscured; volutions six or seven, seen to be regularly convex where the callus is exfoliated; suture impressed; revolving

angle distinct upon the body-volution, and forms a carina as it is continued out upon the spine-like posterior process of the wing. This process diverges widely from the axis of the shell, and curves gently backward; anterior process of the wing moderately large, linguliform, projecting straight outward, and a little forward, and separated from the other process by a notch of moderate width, which is abruptly rounded at the bottom. From the base of the spine-like process, the posterior border of the wing curves gently inward and backward against the spire; anterior border of the wing curving forward from the base of the anterior process and ending in the slender anterior canal; posterior canal or groove narrow, extending back nearly or quite to the apex of the spire. Surface of the wing marked by the ordinary lines of growth, and upon the outer volution of some specimens there are faint indications of revolving striæ.

Full length of the shell, from the apex to the end of the anterior canal, about thirteen millimeters; width across the last volution, including the whole wing, but not the processes, six millimeters.

This species is closely related to *L. nuptialis* of the preceding description, but differs from that species in its less robust form, comparatively smaller wing, more slender and less recurving posterior process, and in the linguliform, instead of lobe-shaped anterior process.

Position and locality.—Strata of the Cretaceous period; east of Mount Taylor, one mile south of Pajuate, New Mexico.

FAMILY TECTURIDÆ.

GENUS ANISOMYON Meek and Hayden, 1860.

Anisomyon borealis Morton, *sp.*

Plate XVIII, fig. 9 *a* and *b*.

Hippoxys borealis Morton, 1842, Jour. Acad. Nat. Sci. Phila., viii, pl. ii, fig. 6.

Helcion carinatus Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 68.

Anisomyon borealis Meek and Hayden, 1860, Am. Jour. Sci., xxviii, 2d s., 35.

Shell obliquely conical; marginal outline broadly oval or suboval; breadth greater than the height; lateral slopes nearly straight or slightly convex; anterior slope concave; posterior slope convex. Surface marked

by conspicuous lines of growth, which are crossed by numerous finer radiating lines. Besides the latter, there are eight slightly-raised radiating ridges extending from the apex to the border, which leave upon the internal cast faint shallow furrows, and where the shell is partially exfoliated they show as narrow linear grooves in its substance. These grooves or ridges are usually arranged with considerable regularity as to their relative distances from each other, but sometimes they are less symmetrically arranged than they are represented in figure 9 *a*. The margin is usually very slightly emarginate at each of the radiating ridges, and seems to have been elevated a little at the front.

Antero-posterior diameter, thirty millimeters; transverse diameter, twenty-five millimeters; height, about twenty millimeters.

Position and locality.—Strata of the Cretaceous period; Gallinas Creek, New Mexico.

Anisomyon centrale Meek.

Plate XVIII, fig. 8 *a* and *b*.

Anisomyon centrale Meek, 1870, Geol. Surv. Wyoming & Contiguous Territories, 312.

Among the collections made at Gallinas Creek, New Mexico, there is a single internal cast in indurated clay, which I refer with comparatively little doubt to *A. centrale* Meek. Its height is proportionally much less than that of typical examples of this species. This imperfection, together with the absence of the test, render it insufficient of itself to base a specific description upon; consequently, I give the substance of Mr. Meek's original description as follows:—

“Shell depressed-conical; apex nearly central; slopes nearly straight all around, but sometimes the anterior and sometimes the posterior slope is a little convex; marginal outline nearly circular or very broadly oval. Surface marked by concentric lines of growth, by slightly-raised radiating striæ, and also by somewhat irregular radiating furrows of unequal depth; the furrows being larger and deeper upon the anterior half of the shell.

“Breadth of the largest specimens seen, 1.16 inches; height, about 0.95 inch.”

Our example is represented in figure 8 *a* and *b*, of natural size, by

which it will be seen to be considerably smaller than the maximum size of Mr. Meek's specimens. It differs somewhat also from his description in having its radiating furrows more irregularly disposed upon the anterior part of the shell, but this is regarded as only an individual variation.

FAMILY TURRITELLIDÆ.

GENUS TURRITELLA Lamarck, 1801.

Turritella uvasana Conrad.

Plate XVIII, fig. 11 *a* and *b*.

Turritella uvasana Conrad, 1856, Pacific Railroad Surveys, v, 321.

Turritella uvasana Gabb, 1864, Paleontology of California, i, 134.

Shell of ordinary size, elongate, slender; sides straight; volutions numerous, apparently reaching eighteen or twenty in number when full-grown; the sides of the volutions nearly straight or only slightly convex; suture broad, deeply impressed.

Surface marked by numerous revolving raised lines, six or eight of which are moderately large, the smaller ones alternating with them. The larger lines are minutely nodose upon the larger volutions, and upon the last one they are sometimes even subspinulose.

All the specimens of this species in the collection are more or less broken, but, judging from the apical angle indicated by their sides, the largest one must have been about five and a half centimeters long, and its last whorl about thirteen millimeters in diameter.

I have referred this species to *T. uvasana* Conrad with some doubt, for several reasons. Both Conrad's and Gabb's descriptions are unsatisfactorily short: Conrad's figure is of only a fragment; Gabb's figure is proportionally more slender than any of our examples; and, finally, Conrad refers his species to the Eocene period. Gabb, however, obtaining his specimens from the typical locality, in Los Angeles County, California, refers the strata there to the Cretaceous period.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

GENUS CASSIOPE Coquand, 1865.

Cassiope Whitfieldi White.

Plate XVIII, fig. 1 a.

Cassiope Whitfieldi, White, 1874, Expl. & Surv. west 100th Merid., Prelim. Rep. Invert. Foss., 27.

Shell moderately large, elongate-conical, umbilicate; volutions apparently about twelve, prominent and prominently angular below the middle of the visible portion, slightly concave from the prominent revolving angle to the suture below, also very slightly and somewhat irregularly concave from that angle to the suture above. A little below the suture there is a rather small, shallow furrow, with its borders above and below raised into more or less distinct revolving ridges. Upon the under side of the last volution, which is rather strongly convex, there are three small revolving ridges, one of them bounding the umbilicus; the other two are placed near each other above the middle of the space, and are continuous to the apex of the shell. It is between the two last-named ridges that the hinder edge of each succeeding volution joins the preceding one. Umbilicus moderately large and deep; aperture subovate in outline; outer lip sinuate, having a broad, shallow notch above its middle, projecting somewhat anteriorly, and rounded abruptly into the umbilicus.

Surface marked by more or less strong undulating lines of growth, apparently without small revolving lines.

Diameter of the last volution of our largest example, nearly four and a half centimeters; the full height of the same, when entire, must have been not far from eleven centimeters.

This shell has nearly the general aspect of *Turritella Mortoni* Conrad, but the presence of an umbilicus separates it generically from that shell.

Dedicated to Mr. R. P. Whitfield, the accomplished paleontologist of Albany, New York.

Position and locality.—Strata of the Cretaceous period; at the head of LeVerken Creek, and also in Pace's Cañon, Utah.

GENUS EULIMELLA Forbes, 1846.

Eulimella funicula Meek.Plate XVIII, fig. 6 *a*.*Eulimella ? funicula* Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 506.

Shell rather small, slender, elongate-conical; sides, from the last volution to the apex, slightly convex; volutions ten or twelve, their sides nearly flat or slightly convex; last volution subangular below the middle; suture linear; aperture oval, rounded anteriorly, subangular posteriorly; inner lip a little thickened; columella imperforate, nearly or quite straight, and in a line with the axis of the shell; surface smooth, apparently polished.

Length, about sixteen millimeters; angle of lateral divergence, eighteen or twenty degrees.

Mr. Meek referred this species to *Eulima* with much hesitation, and suggested (*loc. cit.*) that it might subsequently be found, through the discovery of more perfect specimens, to belong to the genus *Eulimella*. None of our examples show the apex, and it is, therefore, not known whether it is sinistral or not, but the one selected for figuring shows the columella to be simple, and nearly or quite straight, as in true *Eulimella*. I therefore refer it provisionally to that genus.

Position and locality.—Strata of the Cretaceous period; North Fork of Virgin River, Utah.

FAMILY PYRAMIDELLIDÆ.

GENUS TURBONILLA Leach, 1825.

SUBGENUS CHEMNITZIA Conrad, 1860.

Turbonilla (Chemnitzia) melanopsis Conrad (?).Plate XVIII, fig. 10 *a*.

Among the fossils obtained from near the west crossing of Virgin River, Utah, are some imperfect examples of a shell that seems to be identical with *T. melanopsis* Conrad. As these are all too imperfect to base a full description upon, I copy that of the author from the Journal of the Academy of Natural Sciences of Philadelphia, (2d series, vol. iv, p. 287):—"T. (*Chem-*

nitzia) melanopsis.—Subulate; whorls nine, flattened on the sides; ribs regular, slightly curved, about seventeen in number on the body-whorl; revolving lines distinct, unequal, about seventeen in number on the penultimate whorl; suture impressed, slightly waved; aperture long, elliptical.”

SUBORDER TOXOGLOSSA.

FAMILY ADMETIDÆ.

GENUS ADMETE Möller, 1842.

SUBGENUS ADMETOPSIS Meek, 1872.

Admete (Admetopsis) gregaria Meek.

Plate XVIII, fig. 5 *a* and *b*.

Admete? gregaria Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 506.

Shell rather small, subfusiform, excluding the outer lip; spire prominent, tapering to a small apex; volutions six or eight, convex, abruptly rounded in to the suture above; suture well defined; last volution moderately inflated, its length equal to, or a little greater than, one-half the full length of the shell; aperture of moderate size, about as long as the spire, narrowing posteriorly and ending anteriorly, at the base of the columella, in a distinct sinus; columella marked by two spiral folds, the larger one of which blends with the truncated extremity of the columella. The other fold is placed a little above the first and passes backward into the aperture a little more obliquely; inner lip a little thickened along its whole length; outer lip in adult shells moderately thick, its outer margin broadly rounded, and its anterior margin abruptly truncated to the base of the columella.

Surface marked by numerous, more or less strongly-elevated, longitudinal or slightly oblique folds, of regular but gradually-increasing size, coincident with the growth of the shell. These folds are quite distinct upon the middle volutions, scarcely observable near the apex, and sometimes obsolete upon the last volution, or visible only upon its posterior portion. Numerous small, revolving, raised lines cross these folds, often not perceptible between, but distinct upon, the folds, giving them a nodulose or corrugated appearance. These revolving lines are always present and usually conspicuous upon the anterior part of the last volution.

Length of a large example, nineteen millimeters; breadth of its last volution, including the outer lip, ten millimeters.

Mr. Meek described (*loc. cit.*) two other closely-related species, all from the Cretaceous strata at Coalville, Utah, which he proposed to group under the subgeneric name of *Admetopsis*. Their generic characters are very closely like those which distinguish the recent genus *Admete*, but I agree with Mr. Meek in regarding the differences as of at least subgeneric if not full generic value. In *Admetopsis* it is the lower fold upon the columella that is most prominent, being particularly so just where it blends with the truncated end of the columella. In *Admete*, on the contrary, it is usually the second fold that is most prominent. The inner lip also of the former, unlike that of the latter, is thickened along its whole length, and the shells throughout are a trifle more massive than those of *Admete* usually are.

Position and locality.—Strata of the Cretaceous period; North Fork of Virgin River, Utah.

CLASS CEPHALOPODA.

ORDER TETRABRANCHIATA.

FAMILY BACULITIDÆ.

GENUS BACULITES Lamarck, 1801.

Baculites ovatus Say.

Plate XIX, figs. 4 *a*, *b*, and *c*, and 5 *a*, *b*, and *c*.

Among the collections made from Cretaceous strata at a locality south-east of Paria, Utah, there are several specimens of a species of *Baculites*. They are all small, slender shells, and in all observable respects they agree with young examples of *B. ovatus* Say.

It is, however, a noticeable fact that, although a considerable collection of different species of fossils were obtained at that locality, only these very small examples of *Baculites* were found among them. This fact suggests the possibility that these examples may be adult forms and specifically different from *B. ovatus*. In want of further evidence upon this point, however, I do not at present feel warranted in referring them to any other species.

Numerous examples of *B. ovatus* were also obtained from Gallinas Creek, New Mexico, some of which were quite large. A large proportion of these were typical forms of the species. A transverse section of one of these is shown in figure 4 *a*, Plate XIX. Many of the examples, associated with these typical ones, were, however, quite constant in having their sides more flattened than those of typical form, giving an outline of transverse section, such as is shown in figure 5 *b*. The septa in all these last-named examples correspond so nearly with those of the typical forms of *B. ovatus* as described and figured by Hall and Meek that I am disposed to regard them as only a variety of that species. The plan of the septa in this variety is shown in figure 5 *a*, and still more clearly in figure 5 *c*.

FAMILY SCAPHITIDÆ.

GENUS SCAPHITES Parkinson, 1811.

Scaphites Warreni Meek and Hayden.

Plate XIX, fig. 3 *a*.

Scaphites Warreni Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., 177.

The collections contain a single specimen of this species from Cretaceous strata three miles southwest of San Mateo, New Mexico, which, although too imperfect for detailed description, is satisfactorily identified by its visible external characters.

The type-specimens of Meek and Hayden were obtained near the Black Hills, in Nebraska; the following being the substance of their description:—

“Shell small, transversely subovate, moderately compressed, rounded on the dorsum; volutions subcylindrical, increasing gradually in size; non-septate portion of the last turn slightly compressed laterally and deflected from the regular curve of the others so as to become nearly or quite disconnected at the aperture.

“Surface of the inner whorls ornamented by numerous small costæ, which increase chiefly by implantation, and all cross the dorsum very regularly without arching; on the sides of the nonseptate outer chamber,

about every fourth or fifth costa is much more prominent and sharper than the others and extends quite across to the umbilical side, while those between die out or coalesce with the others at various distances.

"Length, 1.45 inches; height, about 1.22 inches; breadth, 0.57 inch."

FAMILY AMMONITIDÆ.

GENUS AMMONITES Bruguière, 1789.

Ammonites Lœvianus White.

Plate XIX, fig. 1 *a* and *b*.

Shell moderately large, robust; volutions four or more, increasing rapidly in size, especially the outer one, so that the umbilicus is rather deep but yet showing all the volutions; each volution embracing between one-quarter and one-third of the width of each preceding one; transverse section of outer volution, between the nodes, oval-subquadrate; surface, upon each side, marked by a row of moderately-elevated, transversely elongate nodes, situated about one-third of the distance from the umbilicus to the dorsum; and also by a row of very prominent nodes on each side of the dorsum. Each of these rows consist of the same number of nodes. The dorsal nodes diverge strongly, but are wholly embraced by each succeeding volution, and do not therefore appear in the umbilicus. Between these two rows of dorsal nodes, the dorsum is slightly convex and the outer surface of the shell appears to have been marked by a small median carina. Between these nodes and the umbilicus, the sides of the volution are broadly convex.

A greater transverse elongation of the lateral nodes than exists on our example would make each continuous with its corresponding dorsal node, which would give to each lateral pair of nodes the character of a rib. It is not improbable that this modification may be found to exist in some examples of the species.

Septa complex; dorsal lobe and part of dorsal saddle unknown; superior lateral lobe moderately large, bifid; lateral saddle about as large as the lateral lobe, but not bifid; inferior lateral lobe small, narrow, not bifid; accessory lobes and saddles few and small; the borders of all the lobes and saddles more or less deeply notched or dentate.

Diameter of the only example in the collections, the larger part of the outer chamber being broken away, fourteen centimeters.

Specific name given in honor of Dr. Oscar Loew.

Position and locality.—Strata of the Cretaceous period; Ojo de los Cuervas, New Mexico.

Ammonites placenta Dekay var. intercalaris Meek and Hayden.

Some more or less imperfect specimens of this species are contained among the collections from Gallinas Creek, New Mexico. A small portion only of the external surface is shown, but this contains in part the characteristics by which Meek and Hayden separate the variety *intercalaris* from the typical forms of the species as published by Dekay. It agrees with the variety above referred to also in being less compressed than the typical forms of *A. placenta* are.

GENUS BUCHICERAS Hyatt, 1875.

Buchiceras Swallovi Shumard.

Plate XX, fig. 1 *a*, *b*, and *c*.

Ammonites Swallovi Shumard, 1860, Trans. St. Louis Acad. Sci., i, 591.

Shell moderately large, flattened-discoid; sides gently convex; dorsum narrowly flattened, the flattened space bordered on each side by a row of more or less distinct nodes; volutions three or four, partially embracing; umbilicus broad, its outline not clearly defined, deep for so discoid a shell, although it has a shallow aspect because of its breadth and want of definite outline, and exhibiting a large part of each of the inner volutions; aperture subovate in outline, its longest diameter directed from the center of the shell, narrowest at the outer end, where it is truncated by the flattening of the dorsum; sides of the volutions marked by prominent, somewhat flexuous, rounded costæ, extending from the inner to the outer edge; the space between each two of these principal costæ is occupied by one or two short ones which do not reach the umbilicus, but they end at the dorsum like the others; upon each costa, near its dorsal end, there is an obtuse node, which, together with the dorsal nodes before mentioned, constitute a double row

of nodes at each side of the dorsum. Saddles all broader, and simpler in outline than the lobes; none of the former being really digitate, and those near the ventral side of the volutions, especially the inner volutions, are nearly as simple in outline as they are in *Ceratites*.

This shell presents some differences from the description by Dr. Shumard of *A. Swallovi*, the principal of which is the absence of the nodes at the umbilical side of the volutions and of the distinct transverse ribs of the dorsum mentioned by him; but these are not regarded as essential specific characters.

Full diameter of the shell, about eighteen centimeters; transverse diameter of the aperture, nearly five and a half centimeters; long diameter of the same, about eight and a half centimeters.

Professor Hyatt writes me, after an examination of the specimen figured on Plate XX, that he regards it as a species of his genus *Buchiceras*, but that "it differs from *B. Syriacum*, the type of the genus, in having the larger lobes and cells more Ammonite-like."

Position and locality.—Strata of the Cretaceous period; Glendale, Long Valley, Utah.

FAMILY TURRILITIDÆ.

GENUS *HELICOCERAS* d'Orbigny, 1842.

Helicoceras Pariense White.

Plate XIX, fig. 2 *a*, *b*, *c*, and *d*.

Shell dextral; spire much depressed; whorls distinct, subcircular or very broadly oval in transverse section, increasing somewhat rapidly in size; surface marked by comparatively strong, rather abruptly-rounded annulations, which cross the whorls obliquely; annulations only slightly prominent upon the inner side of the whorls, but more prominent upon the upper and under sides; upon the outer side of the whorl each annulation bears a pair of prominent nodes, one on each side of the siphuncle, forming two dorsal rows of nodes along the whole length of the shell, the portion of the annulation between each pair of nodes being straightened and slightly flattened upon the beak. The annulations are apparently always

simple, never coalescing, and never failing to completely encircle the volution. The nodes are moderately prominent upon exfoliated specimens, and where the test is preserved they are seen to be subspinous or sharply nodose.

Septa moderately distant, sometimes embracing two annulations, but toward the aperture only one. Lobes all smaller than the saddles, the size in each transverse series gradually diminishing from the dorsal to the ventral one; the smallest saddle, the ventral, not being larger than the largest lobe, the dorsal; lobes all bifurcate, except the ventral, the inferior lateral lobe being but slightly so; the anterior portion of the space between the branches of the dorsal lobe occupied by two backward-projecting points; the ventral lobe is simple, small, narrow, and serrate upon both sides. The saddles of the different longitudinal series all similar in shape, diminishing gradually in size from the dorsal to the ventral series; all broader than long, except the ventral one, the length and breadth of which are about equal; each partially parted at the middle; edges of all the lobes and saddles serrated or toothed.

The longest fragment in the collection measures about seven centimeters. At the larger end of this the long diameter is fifteen millimeters and the short diameter fourteen millimeters; at the smaller end the long diameter is eight and a half millimeters.

This species is similar in aspect to *H. Mortoni* Hall and Meek, but differs from it in diminishing in caliber much more rapidly toward the apex, in the presence of a double series of nodes along the dorsum of the volutions, and in the proportions and details of its lobes and saddles.

Position and locality.—Cretaceous strata; southeast of Paria, Utah.

ARTICULATA.

CLASS VERMES.

ORDER TUBICOLA.

FAMILY SERPULIDÆ.

GENUS SERPULA Linnæus, 1758.

Serpula intrica White.Plate XV, fig. 5 *a*.

Tubes small, slender, cylindrical, smooth, very long and very tortuous, not perceptibly increasing in size, so far as our examples show, but neither the distal nor proximal extremity of the tube has been found unbroken.

Diameter of the tube, a little more than one millimeter.

This species is remarkable for the great length and uniform size of the tubes, and for the intricacy of their contortions.

Position and locality.—Strata of the Cretaceous period; southeast of Paria, Utah.

CHAPTER X.

CENOZOIC AGE.

TERTIARY PERIOD.

MOLLUSCA.

CLASS CONCHIFERA.

ORDER DIMYARIA.

FAMILY UNIONIDÆ.

GENUS UNIO Retzius, 1788.

Unio vetustus Meek.Plate XXII, fig. 12 *a*, *b*, *c*, and *d*.*Unio vetustus* Meek, 1860, Proc. Acad. Nat. Sci. Phila., 312.*Unio priscus* Meek, 1870, Geol. Surv. Wyoming & contiguous Territories, 298.

Shell somewhat elongate-ovate, some examples a little compressed, but old shells usually somewhat gibbous; test moderately thick; beaks placed near the anterior extremity; anterior margin regularly rounded down to the basal margin, which is only slightly convex or a little straightened; dorsal margin nearly straight or a little convex, and nearly parallel with the base; posterior margin obliquely sloping downward and backward from the dorsal margin, and abruptly rounded below to meet the basal margin.

Surface of young shells marked by numerous small, undulating concentric wrinkles, which cease to form as the shell increases in size, and are then seen only upon the beaks; surface of adult shells marked by the ordinary lines of growth; umbonal ridge rounded, not prominent; two somewhat sharply raised lines radiate from just behind the beak obliquely downward and backward upon the space between the umbonal ridge and the dorsal margin.

Cardinal tooth of right valve moderately strong, prominent, conical, curved slightly upward and forward; depressions upon each side of it shallow; cardinal teeth of left valve not very prominent, nearly vertical; the pit between them for the reception of the tooth of the other valve rather deep; lateral teeth narrow, moderately prominent, very slightly curved; anterior adductor scars deep, placed close before and a little below the cardinal teeth; anterior pedal scars so close together as to form a single depression, and placed immediately below the adductor scars.

Some of the specimens in the collection are a little wider posteriorly than anteriorly, and some are also more gibbous than others, which differences are thought to be sexual rather than varietal, since such sexual differences of form are usual among living species of *Unio*.

Length, sixty-seven millimeters; breadth, thirty-nine millimeters. These measurements are of examples that appear to be of medium adult size. Some fragments indicate that the species reaches a considerably larger size, and also that some of them had a greater proportionate length.

Mr. Meek has expressed the opinion, (Geological Survey of Wyoming and contiguous Territories, p. 298,) that this species is identical with *U. priscus* Meek and Hayden, but a still later development of facts leads me to think the strata from which the two forms respectively come, belong to different periods. Therefore I prefer to retain separate names for the two forms at present, although they are so similar.

Position and locality.—Strata probably of Eocene Tertiary age; Wales, Utah.

FAMILY CYRENIDÆ.

GENUS CYRENA Lamarck, 1818.

SUBGENUS VELORITINA Meek, 1872.

Cyrena (Veloritina) Durkeei Meek.

Plate XXI, fig. 13 *a* and *b*.

Cyrena (Corbicula) Durkeei Meek, 1870, Proc. Amer. Philo. Soc. Phila., xi, 431.

Corbicula (Veloritina) Durkeei Meek, 1871, Geol. Surv. Montana and adjacent Territories, 376.

Cyrena (Veloritina) Durkeei Meek, 1874 (manuscript).

Shell rather large for one of the genus, subtriangular in outline, gibbous, especially the upper median portion; posterior and postero-ventral portions

somewhat compressed laterally; front margin abruptly and basal margin broadly rounded; posterior side sloping downward and backward to the postero-basal margin, where it is narrowly rounded to meet the basal margin; beaks elevated, pointed, curving inward and forward, and nearly meeting each other across the hinge. The dorsal margin of each valve behind the beak is bent more or less deeply and sharply inward and downward, forming a prominent curved umbonal ridge, which extends from the beak to the postero-basal border, and completely obscures the line of union of the two valves along the postero-superior margin, as the shell is viewed laterally. This last-named character is a marked feature of the shell, and gives the appearance of unusual elevation to the umbonal ridges.

Surface marked by distinct, concentric lines of growth.

Length from front to postero-basal margin, forty-nine millimeters; height, from base to top of umbo, forty-two millimeters.

Position and locality.—Strata probably of Eocene Tertiary age; plateau near the west crossing of the north fork of Virgin River, at Pace's Cañon, and at the north fork of Virgin River, Utah.

GENUS SPHÆRIUM Scopoli, 1777.

Sphærium ——— (?).

Among the collections made from Tertiary strata west of Fairview, Utah, are some specimens of *Sphærium* that appear to belong to *S. formosum* Meek and Hayden, the type-specimens of which species were obtained from Tertiary strata near Fort Union, Nebraska. They are, however, too imperfect, and the specific characters too inconspicuous to allow their identity to be recognized with certainty.

CLASS GASTEROPODA.

SUBCLASS PULMONIFERA.

ORDER PULMONATA.

SUBORDER BASOMMATOPHORA.

FAMILY LIMNÆIDÆ.

GENUS PLANORBIS Guettard, 1756. *

Planorbis Utahensis Meek.

Plate XXI, fig. 8 a.

Planorbis Utahensis Meek, 1860, Proc. Acad. Nat. Sci. Phila., 314.

Shell moderately large, discoidal, compressed, slightly convex above; test thin; the first two or three volutions often depressed a little below the general surface of the outer ones, making the top slightly concave at center; umbilicus broad, not very deep, showing all the inner volutions plainly; volutions from four to five and a half, rather slender, wider than high, sub-elliptical in transverse section, convexity of the upper side slightly less than that of the lower side; upper side of the outer volution slightly sloping outward and downward to the periphery, which is somewhat narrowly rounded; suture distinct, but not very deep above, deeper and more distinct below; a small part of each volution concealed by the next succeeding one; aperture suboval, slightly expanded laterally.

Surface marked by small oblique lines and occasional small wrinkles of growth. These lines extend obliquely outward and backward, the margin of the aperture also having the same direction.

Greatest breadth of the largest specimen in the collection, twenty-four millimeters. Mr. Meek's type-specimens were obtained from Tertiary strata, which he was disposed to regard as Eocene, in the valley of Ham's Fork, latitude, $41^{\circ} 40'$ north; longitude, $110^{\circ} 10'$ west.

Position and locality.—Strata of Tertiary age; east slope of Pine Mountain and at Castle Valley, Utah.

Planorbis ———(?)

From strata, probably of Eocene Tertiary age, at the head of Soldier's Fork, Utah, some specimens of dark carbonaceous shale were obtained, containing *Unio vetustus* Meek, and which are also crowded with shells of a small *Planorbis*. The shells are of nearly uniform size, averaging about three millimeters in diameter; slightly convex above, narrowly umbilicate below; volutions about three, broader than high, not angulated, marked by ordinary lines and small wrinkles of growth. They appear to be mature shells, but they present too few prominent specific characters to satisfy me of the present propriety of giving them a specific name.

FAMILY PHYSIDÆ.

GENUS *PHYSA* Draparnaud, 1801.*Physa Bridgerensis* Meek.?

Plate XXI, fig. 2 a.

Physa Bridgerensis Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 516.

The collections contain a number of imperfect examples of a species of *Physa*, which seem to belong to *P. Bridgerensis* Meek, the type-specimens of which he obtained from Tertiary strata at Church Buttes, fourteen miles from Fort Bridger, Wyoming Territory. They, however, present some differences which may prove to be of specific importance. The following is the substance of Mr. Meek's description, which I use because none of our specimens shows all the details mentioned by him with clearness, although they are sufficient for the identification of the species. The specimen figured, while it presents the surface-markings and the character of the spire with more clearness than any of the others, is not so large nor quite so robust as most of the other examples are. "Shell large, subovate; spire prominent, conical; volutions from four and a half to five, moderately convex; last one large, but not ventricose; suture well defined; aperture narrow-subovate, arcuate, acutely angular above, and about twice as long as the spire; columella twisted into a rather prominent fold; surface with fine sharp lines of growth."

Position and locality.—Strata of the Tertiary period; San Pete Valley, Utah.

Physa pleromatis White.Plate XXI, fig. 1 *a* and *b*.

Shell large, ovoid, ventricose; test thin; spire short; whorls five or six, moderately convex, last one inflated; suture distinct, somewhat impressed; aperture narrowly subovoid, slightly arcuate, its length nearly equal to three-fourths that of the shell; columella a little twisted, so as to produce a slightly prominent fold. Surface rather smooth, but marked by the usual lines of growth.

Length, thirty-two millimeters; greatest breadth, twenty-two millimeters. Some fragments indicate that the shell often reached a still greater size.

This species differs from *P. Bridgerensis* Meek in its more robust form, shorter spire, more ventricose outer whorl, and in having the upper part of its aperture less acutely angular. It closely resembles the recent species *P. Sayi* Tappan, but the outer whorl of our shell is rather more ventricose and the aperture proportionally narrower, especially its anterior portion.

Position and locality.—Tertiary strata; Last Bluff, Utah.

SUBORDER GEOPHILA.

FAMILY HELICIDÆ.

GENUS *HELIX* Linnæus, 1758.***Helix Leidyi*** Hall and Meek.Plate XXI, fig. 3 *a*, *b*, and *c*.

Helix Leidyi Hall and Meek, 1856, Mem. Amer. Acad. Arts and Sci., v, new series, 394.

Shell rather large, subglobose in form; spire moderately elevated; volutions about six in mature shells, ventricose, especially the outer one; suture distinct, that of the outer volutions more or less impressed; umbilicus small, probably nearly closed; aperture oblique, broad-subovate in outline; outer lip apparently reflexed; surface marked by very numerous uniform, distinct, closely-arranged lines of growth and also by occasional shallow wrinkles.

Position and locality.—The type-specimens of Hall and Meek were obtained from the Eocene Tertiary strata, near the head of Bear Creek, Mauvais Terres, Nebraska. Ours were collected at Moo-se-ne-ah Peak and Pownsagunt Plateau, Utah.

SUBCLASS DICEA.

ORDER PECTINIBRANCHIATA.

SUBORDER TÆNIOGLOSSA.

FAMILY MELANIIDÆ.

GENUS GONIOBASIS Lea, 1862.

Goniobasis tenuicarinata Meek and Hayden.Plate XXI, fig. 10 *a* and *b*.*Melania tenuicarinata* Meek and Hayden, 1857, Proc. Acad. Nat. Sci. Phila., 136.

Shell conical, turreted, moderately elongate; apex somewhat acute; volutions six or seven, convex, but the upper portion of the outer side is a little flattened obliquely; suture deeply impressed; aperture ovoid, obtusely angular at the posterior part, where the outer lip joins the inner one; outer lip sinuous, somewhat prominent below the middle; columella slightly curved; surface marked by the usual regular lines of growth, and also along the middle of the volutions by elevated revolving lines, which vary in number and distinctness in different shells, but in all they are obsolete near the apex. The upper one of these lines is constantly more prominent than any of the others, its prominence sometimes being sufficient to give a somewhat tabulated appearance to the upper part of the whorls; the next most prominent line is a little below the one just mentioned, and in some shells these two only are to be distinctly seen; in other shells the whole surface below these two is marked by other similar but a little less distinct revolving lines.

Length of the largest example in the collection, sixteen millimeters; breadth of body-whorl of the same, nearly eight millimeters.

Position and locality.—Strata of Tertiary age; Wales, Utah.

Goniobasis tenera Hall, *sp.*Plate XXI, fig. 11 *a*, *b*, and *c*.*Cerithium tenerum* Hall, 1845, Expl. Exp. Oregon and Northern California, 308.

Shell turreted, very slender; volutions about twelve, moderately convex, longitudinally plicate; suture impressed; aperture suboval, considerably extended forward; columella curved; outer lip thin.

The longitudinal plications vary somewhat in character and distinctness in different shells and also in different parts of the same shell; they are smaller and more numerous upon the small volutions, and become large, distant, and prominent on the larger ones; all are curved a little outward and forward, none having the exact direction of the axis.

The surface of the shell is marked by numerous small, raised, revolving lines, which are more prominent, and sometimes even slightly spinous, where they cross the longitudinal plications.

Length of the largest specimen in the collection, thirty-two millimeters; breadth of the last volution, nine millimeters.

This shell closely resembles the figure given by Hall of *G. tenera* (= *Cerithium tenerum* Hall, Expl. Exp. Oregon and Northern California, 308), and is, not without some hesitation, referred to that species. There is, however, great variation among the related forms of this genus, as found in the Tertiary rocks of that part of the country, and satisfactory specific discrimination is often impracticable.

Position and locality.—Strata probably of Eocene Tertiary age; head of Soldier's Fork, Utah.

* *Goniobasis Nebrascensis* Meek and Hayden.

Plate XXI, fig. 9 *a*, *b*, and *c*.

Goniobasis Nebrascensis Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 124.

Shell pointed-subovate, elongate; spire moderately elevated, conical; volutions five to seven, depressed-convex; suture distinct, impressed; aperture subovate, narrow behind, abruptly rounded in front; outer lip sinuous, somewhat prominent toward the front; columella curved.

Surface marked by the usual fine lines of growth, and also by a number of more or less distinctly raised revolving lines, which are more distinct upon the middle of the volutions than elsewhere; one line about the middle of the volution is usually a little more prominent than any of the others, which gives it an angulated or subcarinate appearance.

Length of the largest example in the collection, seventeen millimeters;

*The general form of this shell differs somewhat from the typical forms of *Goniobasis*, and approaches somewhat that of *Lioplacodes*; but, so far as I have been able to observe, the aperture is much more nearly like that of the former genus than the latter.

breadth of body-volution, nine millimeters; apical angle varying from forty to forty-five degrees.

Position and locality.—The type-specimens of Meek and Hayden were obtained from Tertiary strata, near Fort Union. Ours are from strata of the same period, Wales, Utah.

FAMILY VIVIPARIDÆ.

GENUS VIVIPARUS Montfort, 1810.

Viviparus trochiformis Meek and Hayden.

Plate XXI, fig. 4 *a*, *b*, and *c*.

Paludina trochiformis Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., 122.

Viviparus trochiformis Meek, 1872, Geol. Surv. Montana, Idaho, Wyoming, and Utah, 478.

Shell trochiform; spire somewhat broadly conical; apex acute; volutions five or six, moderately convex, marked by a greater or less number of slightly raised revolving lines; the last volution angular or abruptly rounded below the middle; suture linear, usually indistinct, especially between the larger volutions, but rather more distinct between those near the apex; aperture subcircular or subtetrahedral; lip thin, reflexed against the columella in front, by which a small umbilical suture or groove is produced; columella arcuate.

This species presents considerable variation in form and appearance, and also in the character of the revolving lines; upon some examples these lines are few and indistinct, especially upon the body-whorl, but upon others they are numerous, and sometimes one or two of them are found to assume the character of small carinæ.

Surface marked also by the ordinary lines of growth.

Length, about twenty-three millimeters; breadth of body-whorl, eighteen millimeters; apical angle, about seventy-five degrees, but the spire is a little convex-conical.

Position and locality.—Strata of Tertiary age at the following localities in Utah: Last Bluff; Ephraim City; south of Last Bluff; east of Joe's Valley; and at the head of Soldier's Fork.

Viviparus trochiformis, var.

Plate XXI, fig. 5, *a* and *b*.

Associated with typical forms of *V. trochiformis* at a locality south of

Last Bluff, Utah, are some that differ considerably from them. They, however, possess the general characteristics of the species, and are, therefore, regarded as only varietal examples. One of these is figured as indicated above. It is more elongate, sutures more distinct, and the revolving lines more obscure than they usually are in typical examples.

Length, twenty-two millimeters; breadth of body-whorl, fourteen millimeters.

***Viviparus ionicus* White.**

Plate XXI, fig. 6 *a* and *b*.

Shell of medium size, broadly trochiform; spire moderately elevated; volutions five or six, prominent; inner ones convex; outer one more or less flattened upon the upper side, forming thus a more or less distinct angle with the rounded outer side; under side broadly rounded; suture distinct.

Surface marked by the usual lines of growth and apparently also by small raised revolving lines. Upon the outer volution below its middle there is a prominence made more or less conspicuous by the presence upon it of a revolving raised line. In some examples this prominence amounts almost to an angulation of the lower portion of the body-whorl.

Length, about nineteen millimeters; breadth of body-whorl, seventeen millimeters.

The examples contained in the collections are all preserved in a fine-grained sandstone and the surface-markings are not distinctly shown; but its broadly turbinate form and the more or less distinctly tabulated character of the upper part of the body-whorl sufficiently distinguish the species.

Position and locality.—Strata probably of Tertiary age; east side of Joe's Valley, Utah.

***Viviparus* ? ——— ?**

Plate XXI, fig. 7 *a* and *b*.

Associated with the other species just described, at Wales, Utah, numerous examples of a small shell were obtained which are probably the young of a species of *Viviparus* or some nearly allied shell. They are possibly adult, but the features by which they might be specifically characterized are too indefinite to justify a specific description and name before the associated forms have all been carefully studied.

ARTICULATA.

CLASS CRUSTACEA.

ORDER OSTRACODA.

FAMILY CYPRIDINIDÆ.

GENUS CYPRIS Müller, 1785.

Cypris —— ?

At a locality west of Fairview and another at the head of Soldier's Fork, Utah, associated with some of the foregoing species, the minute shells of a species of *Cypris* are very abundant. They are all compressed in shale and too much injured to allow of a satisfactory specific determination, but they are probably identical with *Cypris Leidyi* Evans and Shumard. The type-specimens of that species were obtained from the "vicinity of Reno Creek, a tributary of Teton or Little Missouri, about ninety miles from Fort Pierre Chouteau."

INDEX OF PART I.*

*The names in *italics* are those of new species described in either this or the Preliminary Report.

	Page.		Page.
<i>Acrotreta pyxidicula</i>	53	Carboniferous age, fossils of	79
<i>Acroteta ? subsidua</i>	34	period, fossils of	96
<i>Actinocrinus viaticus</i>	82	observations on	15
<i>Admete gregaria</i>	198	<i>Cassiope Whitfieldi</i>	196
<i>Admetopsis gregaria</i>	198	Cenozoic age, fossils of	206
<i>Agnostus interstrictus</i>	38	<i>Chætetes Dalii</i>	66
<i>Allorisma subcuneata</i> var.	155	milleporaceus	98
<i>Ammonites Lovianus</i>	201	<i>Chemnitzia melanopsis</i>	197
<i>Ammonites Swallovi</i>	202	<i>Chonetes granulifera</i>	122
<i>placenta</i> var.	202	<i>mesoloba</i>	123
<i>Anchura ? fusiformis</i>	190	<i>Chonetes platynota</i>	121
<i>Anchura nuptialis</i>	192	<i>Cladograpsus</i> , note on	62
<i>Anisomyon borealis</i>	193	Classification, observations on	21
<i>centrale</i>	194	table of	22
<i>Archæocidaris ornatus</i>	104	<i>Climacograptus</i> , note on	62
<i>Archæocidaris tridifer</i>	104	<i>Conocardium</i> ——— ?	94
<i>Asaphiscus Wheeleri</i>	43	<i>Conocoryphe Kingii</i>	40
<i>Athyris obmaxima</i>	92	<i>Corbula nematophora</i>	188
<i>subtilita</i>	141	Cretaceous period, fossils of	169
<i>Aviculopecten Corcyanus</i>	147	observations on	18
<i>Aviculopecten interlineatus</i>	149	<i>Cruziana Linarssoni</i>	32
<i>McCoyi</i>	149	<i>rustica</i>	33
<i>occidentalis</i>	146	<i>Cymella undata</i>	187
<i>Baculites ovatus</i>	199	<i>Cyrena</i> (<i>Veloritina</i>) <i>Durkeei</i>	207
var.	200	<i>Cypris</i> ——— ?	216
<i>Bakevella parva</i>	153	<i>Cyrtoceras</i> ——— ?	57
<i>Bathyurellus Wheeleri</i>	43	<i>Dentalium canna</i>	156
<i>Bellerophon allegoricus</i>	55	<i>Dicelloccephalus ? flagricaudus</i>	60
<i>Bellerophon crassus</i>	157	<i>Dielasma bovidens</i>	144
<i>Buchiceras Swallovi</i>	202	<i>Burlingtonensis</i>	93
<i>Camaroceras colon</i>	56	<i>Eulimella ? funicula</i>	197
<i>Camptonectes bellistriatus</i>	165	<i>Euomphalus luxus</i>	94
<i>Camptonectes platessa</i>	176	<i>Euomphalus pernodosus</i>	158
<i>stygius</i>	164	(<i>Raphistoma ?</i>) <i>trochiscus</i>	77
Canadian period, fossils of	50	<i>Exogyra costata</i> var. <i>fluminis</i>	174
observations on	8	<i>læviuscula</i>	173

	Page.		Page.
<i>Rhynchonella argenturica</i>	75	<i>Syringopora Harveyi</i>	80
<i>metallica</i>	129	<i>multattenuata</i>	100
<i>Rhynchonella Rockymontana</i>	131	Table of classification of fossils	22
<i>Uta</i>	128	<i>Terebratula (Dielasma) bovidens</i>	144
<i>Rhynchonella Wasatchensis</i>	130	<i>Burlingtonensis</i>	93
<i>Scaphites Warreni</i>	200	Tertiary period, fossils of	206
<i>Schizodus Wheeleri</i>	154	observations on	18
<i>Serpula intricata</i>	205	Thallogens	32
<i>Sphærium</i> ——— ?	208	<i>Theca primordialis</i>	37
<i>Spirifer cameratus</i>	132	Tracks of a Crustacean ?	49
<i>centronatus</i>	86	<i>Trematis pannulus</i>	36
<i>extenuatus</i>	88	Trenton period, fossils of	62
(Martinia) <i>glaber</i> , var. <i>contracta</i>	136	observations on	9
<i>peculiaris</i>	90	Triassic period mentioned	17
<i>planoconvexus</i>	135	<i>Trigonia</i> ——— ?	167
<i>Rockymontanus</i>	134	<i>Turbonilla (Chemnitzia) melanopsis</i>	197
<i>striatus</i>	88, 134	<i>Turritella uvasana</i>	195
<i>Spiriferina Kentuckensis</i>	138	<i>Unio vetustus</i>	206
<i>octoplicata</i>	139	<i>Velatella carditoides</i>	189
<i>Spirigera monticola</i>	91	<i>Veniella goniophora</i>	185
<i>Spirigera obmaxima</i>	92	<i>Vestigia</i>	49
<i>planosulcata</i>	143	<i>Viviparus ionicus</i>	215
<i>subtilita</i>	141	<i>Viviparus trochiformis</i>	214
<i>Strophomena fontinalis</i>	54	——— ?	215
<i>Strophomena filitexta</i>	69	Whitfield, R. P., on age of shales at Norman's	
<i>rhomboidalis</i>	85	Kill	19
Subcarboniferous period, fossils of	79	<i>Zaphrentis excentrica</i>	101
observations on	12	——— ?	68
<i>Synocladia biserialis</i>	107		

EXPLANATION OF PLATE I.

FIG. 1. *CRUZIANA RUSTICA*. (Page 33.)

- a.* A large but imperfect specimen.
- b.* A still smaller fragment, showing the manner of the breaking-up of the bodies before they became embedded.

FIG. 2. *CRUZIANA LINNARSSONI*. (Page 32.)

- a.* Typical form of the species, showing stipe in place.
- b.* Probably the same species as 2 *a.*
- c.* Same as 2 *b*, side view.

FIG. 3. *ACROTRETA* ? *SUBSIDUA*. (Page 34.)

- a.* Interior view of ventral valve, enlarged; details impaired by weathering.
- b.* Interior view of dorsal valve, enlarged; similarly impaired by weathering.
- c.* Profile view, showing the thickness of the shell and convexity of the valves.
- d.* Internal cast of part of a dorsal valve, probably of the same species.

FIG. 4. *TREMATIS PANNULUS*. (Page 36.)

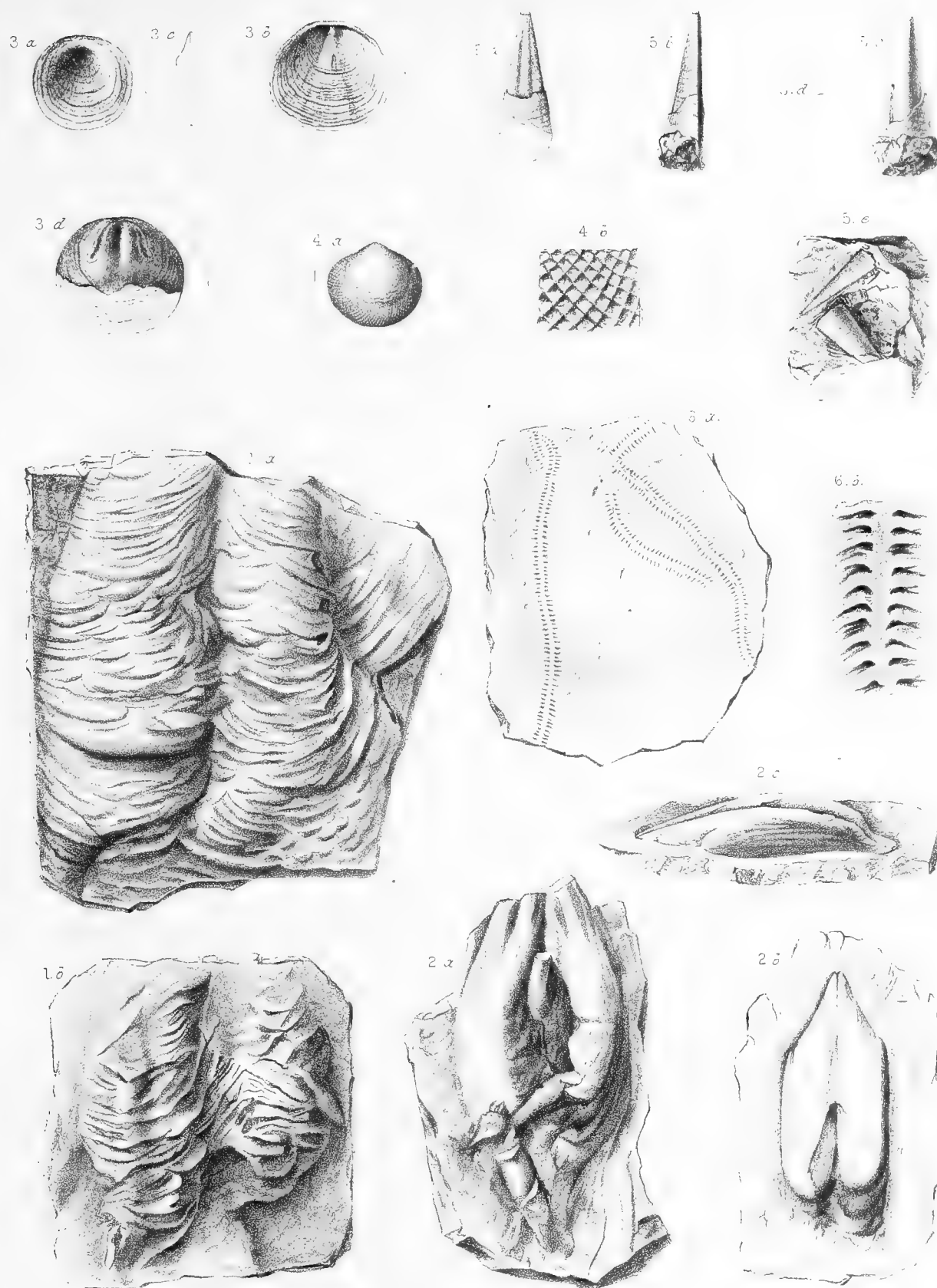
- a.* View of one valve, enlarged.
- b.* Fragment of the same, magnified, to show character of surface-markings.

FIG. 5. *HYOLITHES PRIMORDIALIS* ? (Page 37.)

- a.* View of flattened or dorsal side, a little enlarged.
- b.* The same, lateral view.
- c.* The same, view of ventral or convex side.
- d.* The same, outline of transverse section.
- e.* Fragment of rock containing two specimens partly embedded.

FIG. 6. TRACKS, PROBABLY OF A SMALL CRUSTACEAN. (Page 49.)

- a.* Natural size.
- b.* The same, enlarged, showing each track to have been more than once impressed by organs of locomotion of similar shape and size.



EXPLANATION OF PLATE II.

FIG. 1. *ASAPHISCUS WHEELERI*. (Page 43.)

- a.* A full-sized individual, outlines restored.
- b.* Young individual.
- c.* Fragment, showing course of facial suture and characters of the glabella.
- d.* Individual of medium size, showing thorax and pygidium complete.
- e.* Separate thoracic segment, enlarged.
- f.* Pygidium; crust of broad border partly removed, showing the character of the striation upon its under surface.

FIG. 2. *CONOCORYPHE (PTYCHOPARIA) KINGII*. (Page 40.)

- a.* Adult individual.
- b.* Young individual, showing its greater proportionate size of head and length of cheek-spines.
- c.* Another young individual, much enlarged, showing the faint lines passing from the front end of each eye to the glabella; movable cheeks separated at the facial sutures.

FIG. 3. *OLENELLUS GILBERTI*. (Page 44.)

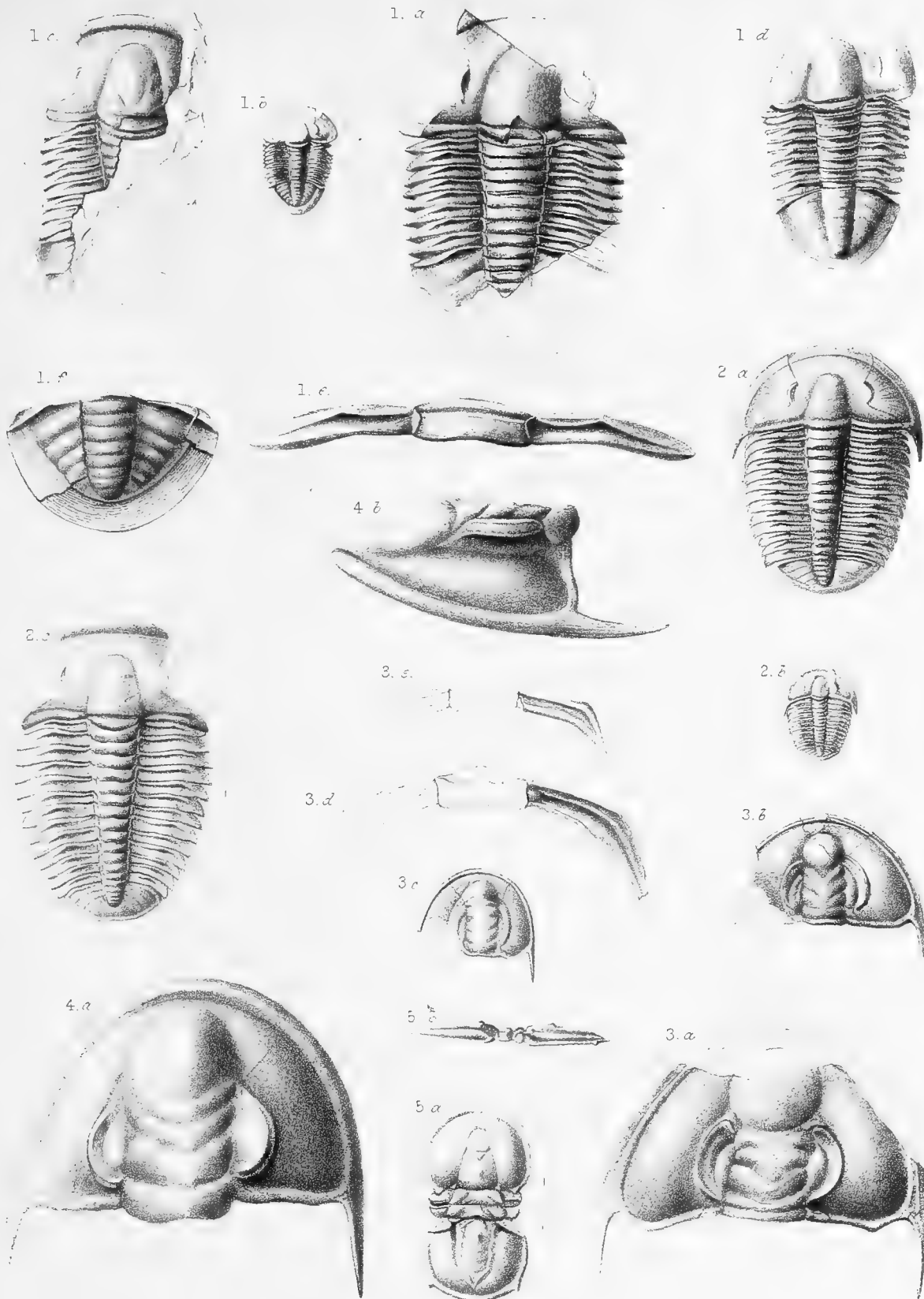
- a.* Head, full size, broken outlines restored.
- b.* Head, not full-grown.
- c.* Head, young.
- d.* Long third pleura, with remainder of thoracic segment restored.
- e.* Pleura of another segment; missing parts restored.

FIG. 4. *OLENELLUS HOWELLI*. (Page 47.)

- a.* Head, full size, top view.
- b.* The same, side view.

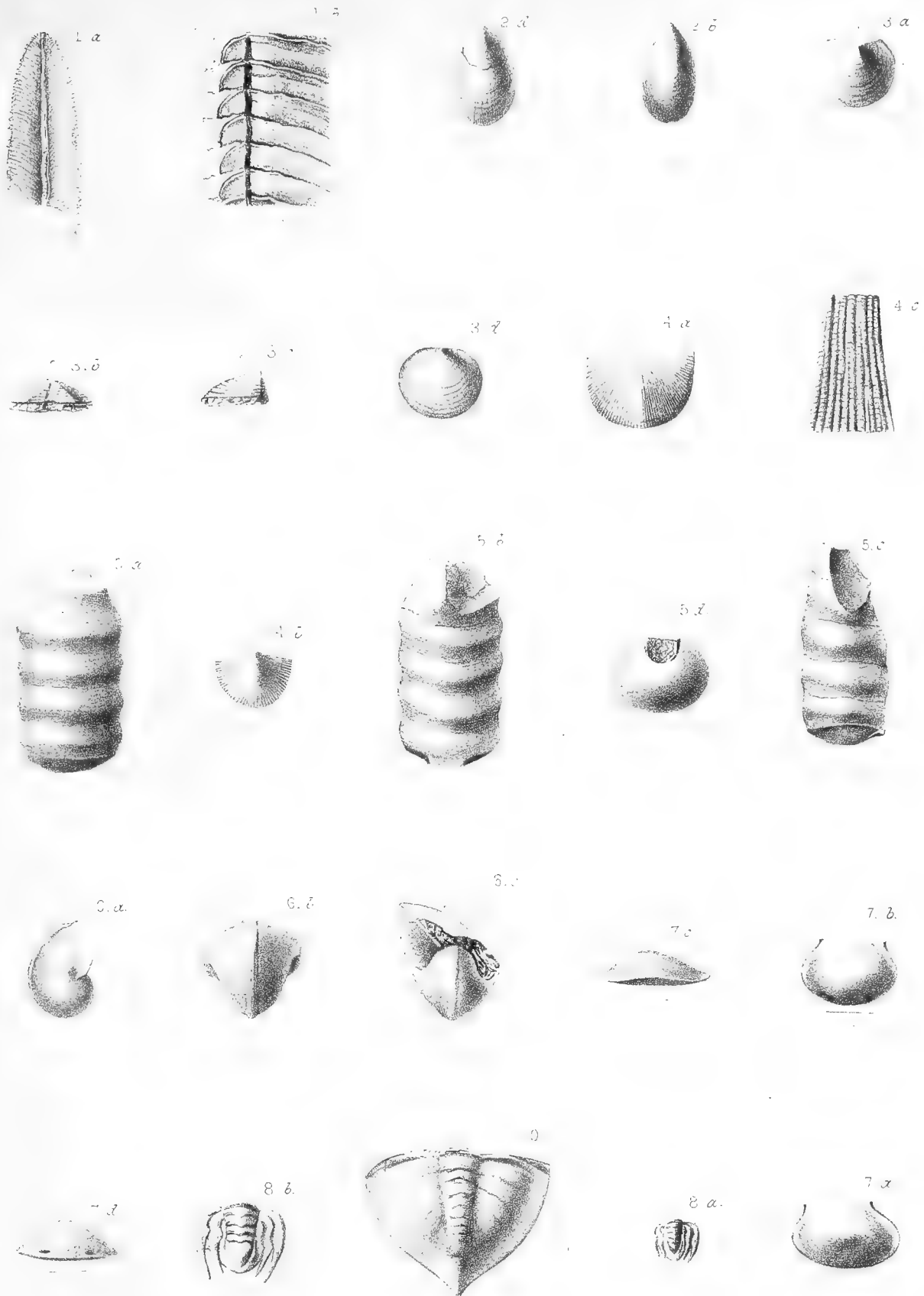
FIG. 5. *AGNOSTUS INTERSTRICTUS*. (Page 38.)

- a.* Top view, much enlarged.
- b.* The same, side view.



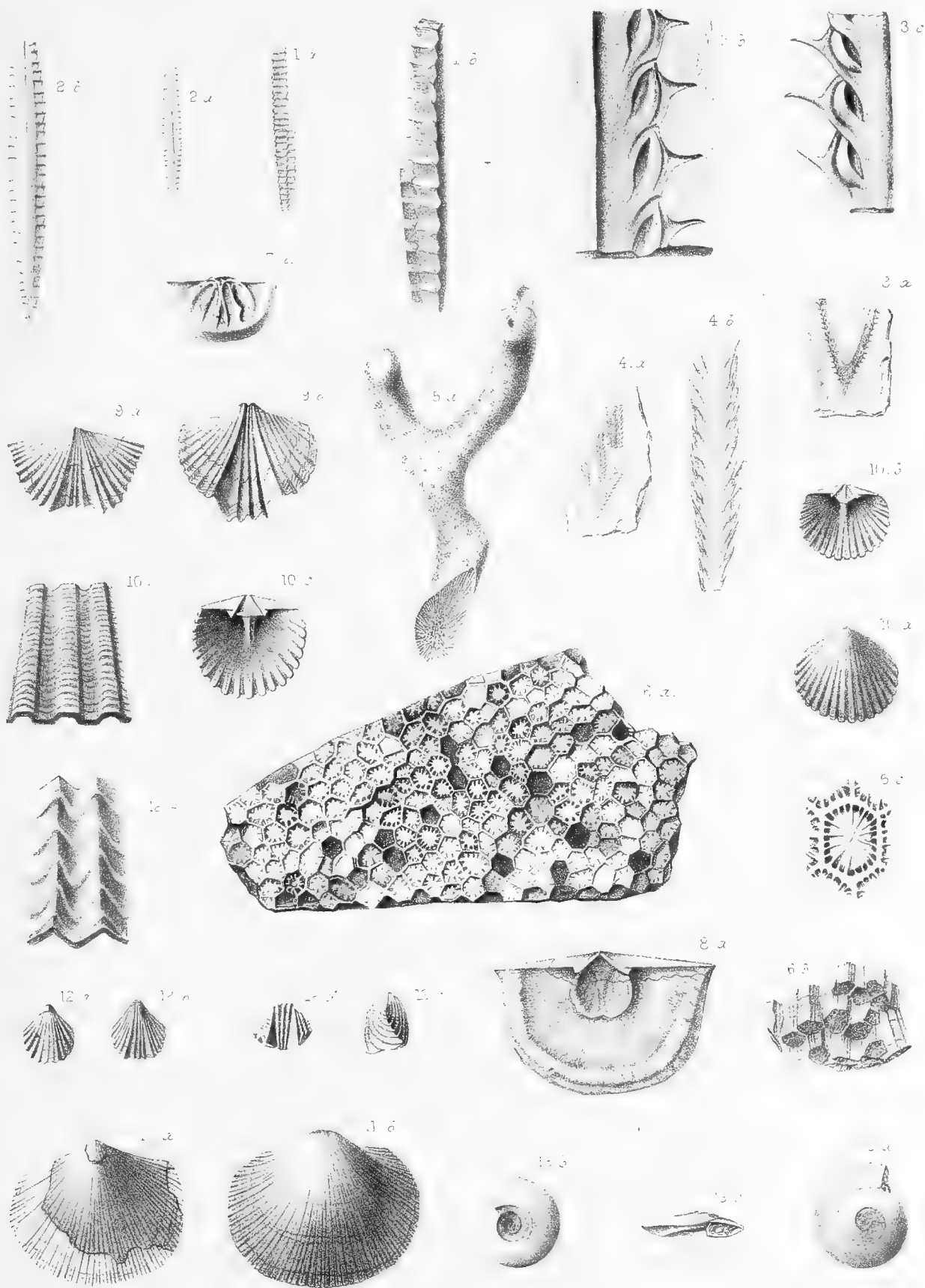
EXPLANATION OF PLATE III.

- FIG. 1. *PHYLLOGRAPTUS LORINGI*. (Page 51.)
a. Side view of stipe, natural size.
b. Portion of same, enlarged, showing shape of cell-apertures.
- FIG. 2. *LINGULA* ? *MANTICULA*. (Page 52.)
a. Dorsal valve.
b. Ventral valve.
- FIG. 3. *ACHROTRETA PYXIDICULA*. (Page 53.)
a. Exterior view of ventral valve.
b. Posterior view of the same.
c. Side view of the same.
d. Dorsal valve.—All very much enlarged.
- FIG. 4. *STROPHOMENA FONTINALIS*. (Page 54.)
a. Dorsal valve.
b. Ventral valve of another and smaller shell.
c. Fragment of *a*, enlarged, showing bifurcation of striæ and their fine crenulation.
- FIG. 5. *ORTHOCERAS* (*CAMAROCERAS*) *COLON*. (Page 56.)
a, b, and c. Different lateral views.
d. View of the convex side of a septum, showing shape, size, and position of the siphuncle.
- FIG. 6. *BELLEROPHON ALLEGORICUS*. (Page 55.)
a. Side view.
b. Dorsal view.
c. Posterior view.
- FIG. 7. *LEPERDITIA BIVIA*. (Page 58.)
a. Left valve.
b. Right valve.
c. View of lower edge of left valve, showing the beveled border.
d. View of lower edge of right valve, showing the position of the two pores.
- FIG. 8. *DICELLOCEPHALUS* ? *FLAGRICAUDUS*. (Page 60.)
a. Natural size.
b. The same, enlarged.
- FIG. 9. *MEGALASPIS BELEMNURUS*. (Page 59.)



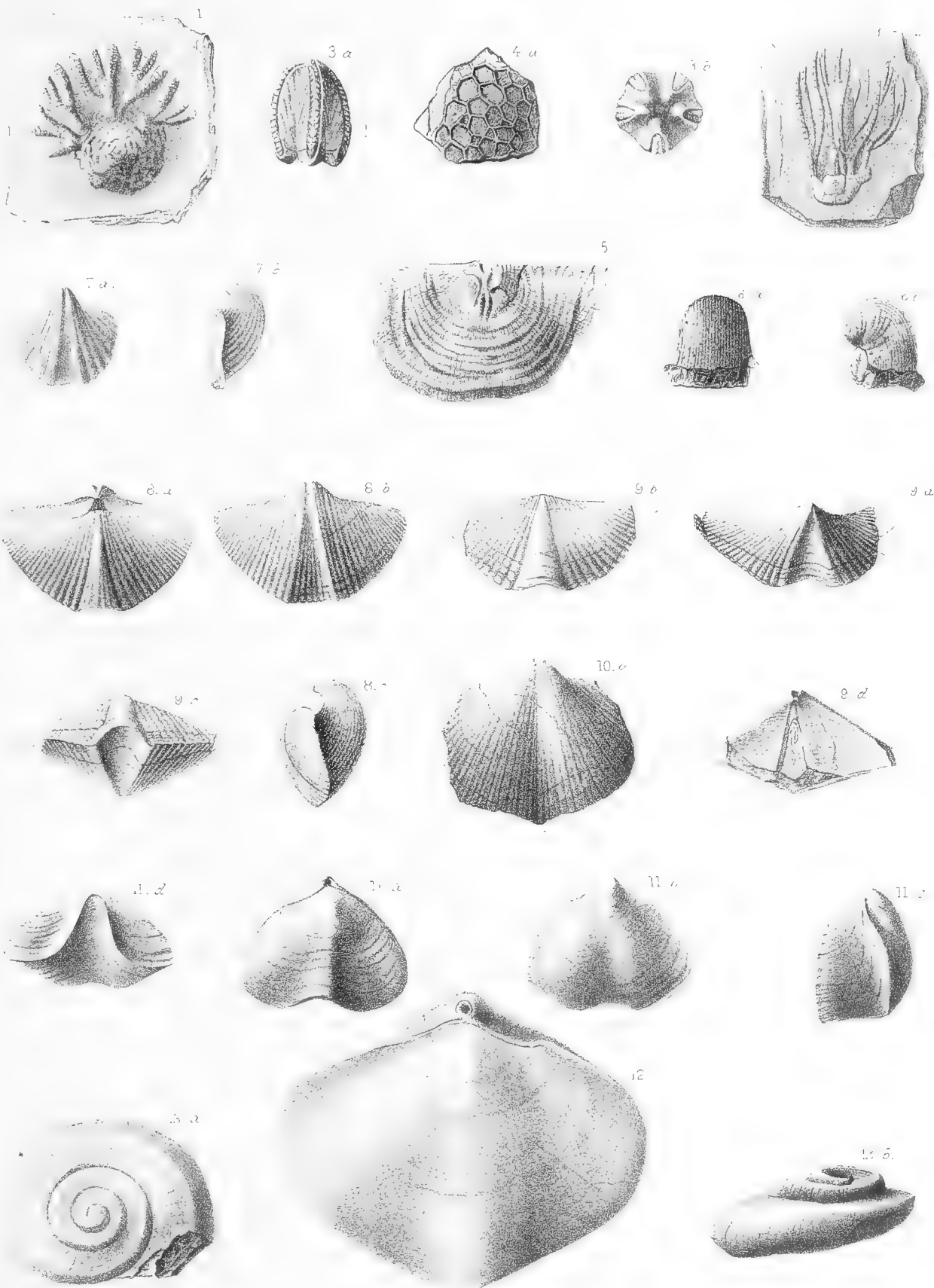
EXPLANATION OF PLATE IV.

- FIG. 1. *GRAPTOLITHUS QUADRIMUCRONATUS* ?. (Page 65.)
a. View of one side of a stipe, enlarged two diameters.
b. Same, still more enlarged from gutta-percha impression, showing shape of the cells.
- FIG. 2. *GRAPTOLITHUS (DIPLOGRAPTUS) PRISTIS* ?. (Page 65.)
a. Natural size.
b. Same, enlarged.
- FIG. 3. *GRAPTOLITHUS RAMULUS*. (Page 62.)
a. Natural size.
b. Part of same, enlarged.
c. Another part of the same, enlarged from gutta-percha cast, the specimen being a natural mold in shale.
- FIG. 4. *GRAPTOLITHUS (DIPLOGRAPTUS) HYPNIFORMIS*. (Page 63.)
a. Natural size.
b. Same, enlarged.
- FIG. 5. *MONTICULIPORA DALII*. (Page 66.)
a. Side view of stem, showing its broken end.
- FIG. 6. *FAVISTELLA STELLATA*. (Page 67.)
a. Top view, natural size.
b. Side view of cells, showing longitudinal striation of the walls.
c. Single cell, enlarged, showing rays.
- FIG. 7. *LEPTÆNA SERICEA* ?. (Page 70.)
a. Interior view of dorsal valve.
- FIG. 8. *STROPHOMENA FILLITEXTA*. (Page 69.)
a. Interior view of ventral valve.
- FIG. 9. *ORTHIS BIFORATA* var. *LYNX*. (Page 74.)
a. Ventral valve.
b. Another ventral valve, having hinge-line shorter, and mesial sinus deeper at front than usual.
- FIG. 10. *ORTHIS PLICATELLA* ?. (Page 72.)
a. Exterior of ventral valve.
b. Interior of dorsal valve.
c. Interior of another dorsal valve, enlarged.
d. Fragment, enlarged, showing concentric striæ.
- FIG. 11. *ORTHIS OCCIDENTALIS*. (Page 70.)
a. Ventral valve, exterior view.
b. Dorsal valve, exterior view.
- FIG. 12. *RHYNCHONELLA ARGENTURBICA*. (Page 75.)
a. Dorsal view.
b. Ventral view.
c. Side view.
d. Front view.
e. Fragment, enlarged, showing concentric, raised lines.
- FIG. 13. *RAPHISTOMA TROCHISCUS*. (Page 77.)
a. Top view.
b. Umbilical view.
c. Side view.



EXPLANATION OF PLATE V.

- FIG. 1. *ACTINOCRINUS VIATICUS*. (Page 82.)
Basal view; partly embedded in stone.
- FIG. 2. *PLATYCRINUS* ——— ? (Page 81.)
Side view; partly embedded in stone; the radial plates in part restored.
- FIG. 3. *GRANATOCRINUS LOTOBLASTUS*. (Page 80.)
a. Side view, enlarged.
b. Basal view of same.
- FIG. 4. *FAVOSITES DIVERGENS*. (Page 79.)
a. Top view, showing form of the cells.
- FIG. 5. *STROPHOMENA RHOMBODALIS*. (Page 85.)
Ventral valve, partially exfoliated.
- FIG. 6. *PRODUCTUS PARVUS*. (Page 83.)
a. Front view of ventral valve.
b. Side view of the same.
- FIG. 7. *SPIRIFER (MARTINIA) PECULIARIS*. (Page 90.)
a. Ventral valve.
b. Side view of the same.
- FIG. 8. *SPIRIFER CENTRONATUS*. (Page 86.)
a. Dorsal view.
b. Ventral view of the same.
c. Lateral view of the same.
- FIG. 9. *SPIRIFER (SYRINGOTHYRIS) EXTENUATUS*. (Page 88.)
a. Ventral view.
b. Dorsal view of the same.
c. Front view of the same.
d. Posterior view of the same.
- FIG. 10. *SPIRIFER STRIATUS*. (Page 88.)
a. Exterior view of ventral valve.
- FIG. 11. *SPIRIGERA MONTICOLA*. (Page 91.)
a. Dorsal view.
b. Ventral view of the same.
c. Lateral view of the same.
d. Front view of the same.
- FIG. 12. *SPIRIGERA OBMAXIMA*. (Page 92.)
The part to the left of the oblique line has been restored by use of fragments of other examples.
- FIG. 13. *EUOMPHALUS LUXUS*. (Page 94.)
a. Top view.
b. Lateral view of another example.



EXPLANATION OF PLATE VI.

FIG. 1. LITHOSTROTION WHITNEYI. (Page 103.)

- a. Mass of embedded corallites, natural size.
- b. Longitudinal section of a corallite, showing vesicles, tabulæ, and, in part, the columella.
- c. A similar section, made a little to one side of the columella, so that the tabulæ seem to be plain.

FIG. 2. CHLETETES MILLEPORACEUS. (Page 98.)

- a. Side view of broken specimen, showing capilliform tubes.

FIG. 3. ZAPHRENTIS EXCENTRICA. (Page 101.)

- a. Side view, showing a part of the calyx, the greater part being broken away.

FIG. 4. LOPHOPHYLLUM PROLIFERUM var. SAURIDENS. (Page 101.)

- a. Side view of rather large example.
- b. Longitudinal section of the same, the calyx filled with stony material.
- c. Transverse section of a corallum, just below the calyx.
- d. Broken example, showing the manner in which the outer portions separate from the columella.
- e. Typical example of *L. proliferum* from Springfield, Ill.

FIG. 5. RHOMBOPORA LEPIDODENDROIDES. (Page 99.)

- a. Fragment of a corallum, natural size.
- b. Part of the same, enlarged.
- c. Small part of the same, still more enlarged.
- d. Portions of silicified stems, having calcareous cores.

FIG. 6. FUSULINA CYLINDRICA. (Page 96.)

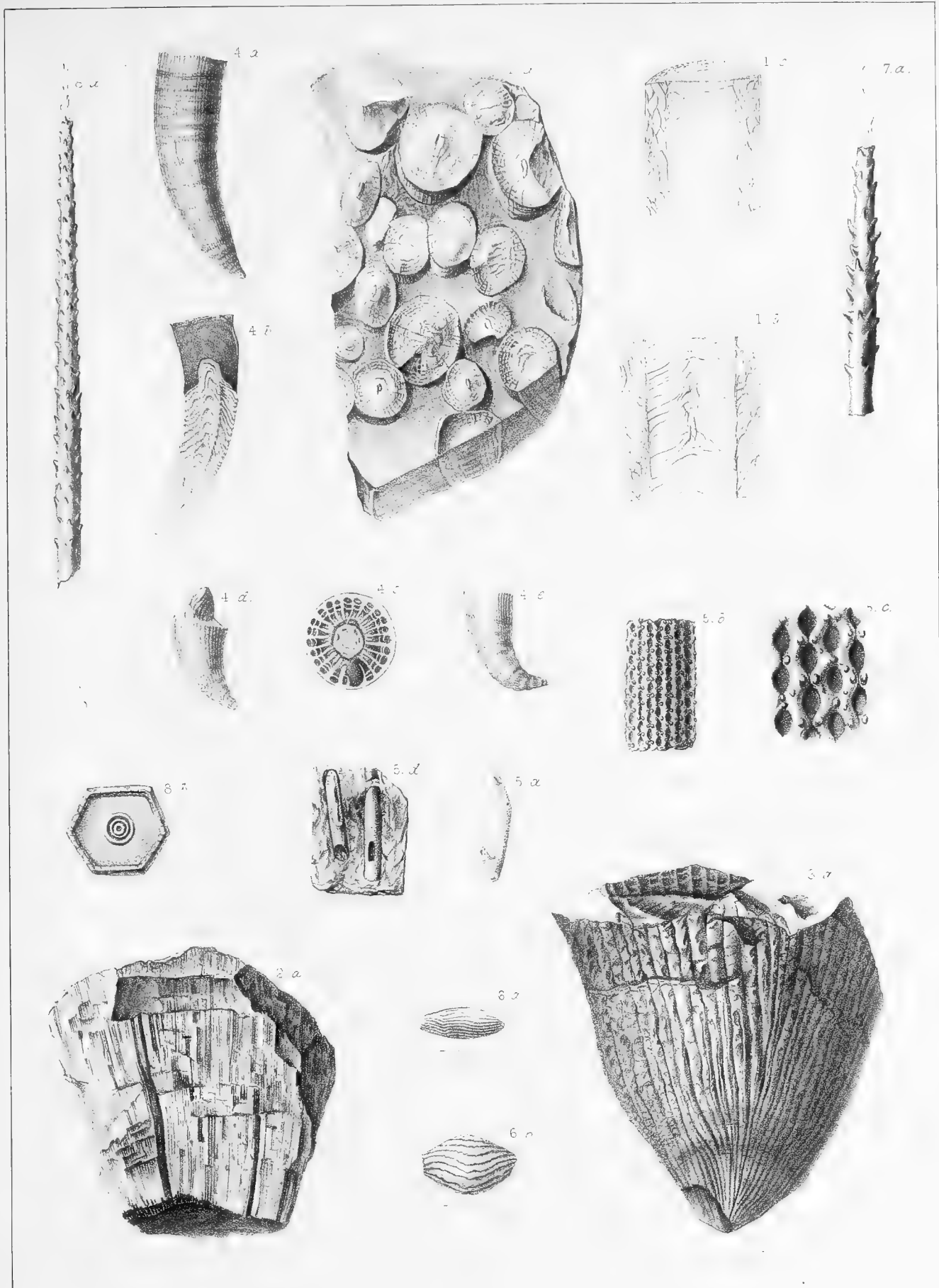
- a. Elongate form, natural size.
- b. Subglobose form, natural size, a little broken at each end.

FIG. 7. ARCHÆOCIDARIS ORNATUS. (Page 104.)

- a. Side view of one of the principal spines.

FIG. 8. ARCHÆOCIDARIS TRUDIER. (Page 104.)

- a. One of the principal spines, rather above average size.
- b. Interambulacral plate.





EXPLANATION OF PLATE VII.

FIG. 1. *PRODUCTUS PRATTENIANUS*. (Page 113.)

- a.* Ventral view of a large example.
- b.* Side view of an average-sized example.
- c.* Posterior view of the same.

FIG. 2. *PRODUCTUS PUNCTATUS*. (Page 114.)

- a.* Ventral view of a typical example from Iowa.
- b.* Dorsal view of the same.
- c.* Lateral view of an example distorted by pressure.

FIG. 3. *SYNOCLADIA BISERIALIS*. (Page 107.)

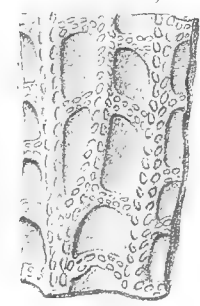
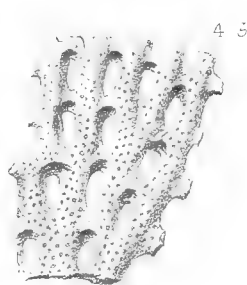
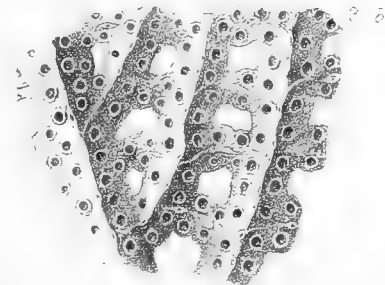
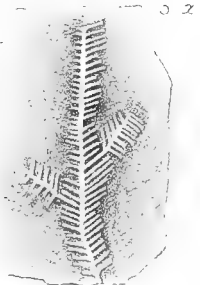
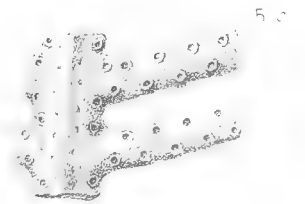
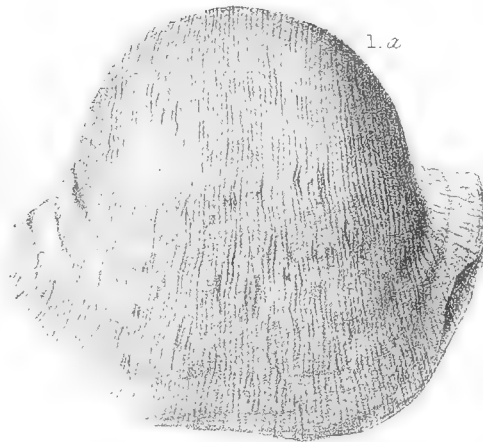
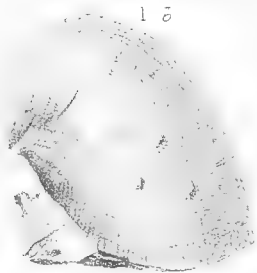
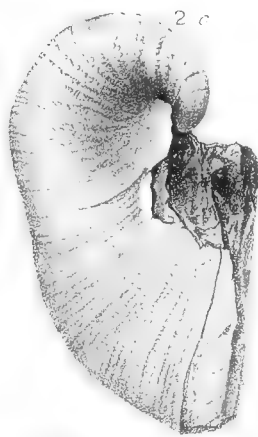
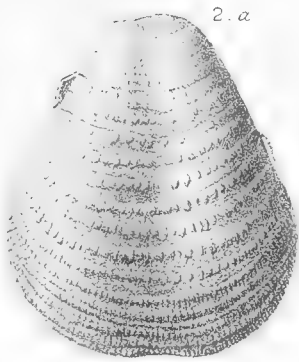
- a.* Portion from near the base of the polyzoary, natural size.
- b.* Portion of another example, enlarged, showing pores (after Meek).
- c.* Enlarged view of a specimen split through all the cells, showing them to be larger below than they are at the apertures.

FIG. 4. *POLYPORA STRAGULA*. (Page 108.)

- a.* Fragment from near the base of the polyzoary, natural size.
- b.* Portion of the same, enlarged, showing the pores. The rows of pores as shown in the figure are too distinct vertically, and not enough so obliquely.

FIG. 5. *GLAUCONOME NEREIDIS*. (Page 105.)

- a.* Fragment of a polyzoary, a little enlarged.
- b.* Part of the same, more enlarged.
- c.* A portion, still more enlarged, showing the dimorphous pores.
- d.* View of non-poriferous side, a little enlarged.
- e.* Same, more enlarged.



EXPLANATION OF PLATE VIII.

FIG. 1. *PRODUCTUS SEMIRETICULATUS* var. *IVESII*. (Page 111.)

- a.* Ventral view of specimen of ordinary size.
- b.* Lateral view of the same.
- c.* Dorsal view of a typical example of *P. semireticulatus* from Southern Iowa; introduced for comparison.

FIG. 2. *PRODUCTUS COSTATUS*. (Page 109.)

- a.* Ventral view of a typical example of the American form of this species.
- b.* Dorsal view of the same.
- c.* Ventral view of another example.
- d.* Lateral view of the same.

FIG. 3. *PRODUCTUS NEBRASCENSIS*. (Page 116.)

- a.* Typical example from Nebraska, ventral view. The spines are represented a little too coarse in the figures.
- b.* Dorsal view of the same.
- c.* Partially-exfoliated example from near Santa Fé.
- d.* Lateral view of the same.

FIG. 4. *PRODUCTUS MURICATUS*. (Page 120.)

- a.* Ventral view of a partially-exfoliated example.
- b.* Posterior view of the same.
- c.* Lateral view of the same.

FIG. 5. *PRODUCTUS LONGISPINUS*. (Page 118.)

- a.* Ventral view of a typical form of the American shell.
- b.* Dorsal view of the same.
- c.* Ventral view of a variety from near Santa Fé.
- d.* Dorsal view of the same.

FIG. 6. *PRODUCTUS MEXICANUS*. (Page 120.)

- a.* Ventral view of a specimen from Nevada.
- b.* Lateral view of the same.
- c.* Posterior view of the same.



EXPLANATION OF PLATE IX.

FIG. 1. *RHYNCHONELLA ROCKYMONTANA*. (Page 131.)

- a.* Ventral valve, having only two plications in the sinus.
- b.* Another ventral valve, having four plications in the sinus.
- c.* Lateral view of another example.
- d.* Front view of the same.

FIG. 2. *RHYNCHONELLA UTA*. (Page 128.)

- a.* Ventral view of a large example.
- b.* Dorsal view of the same, partially restored.
- c.* Lateral view of the same.

FIG. 3. *RHYNCHONELLA ? WASATCHENSIS*. (Page 130.)

- a.* Ventral view of an example from the Wasatch range.
- b.* Dorsal view of the same.
- c.* Lateral view of the same.
- d.* Front view of the same.

FIG. 4. *MEEKELLA STRIATOCOSTATA*. (Page 126.)

- a.* Ventral view of a globose form from Southern Iowa.
- b.* Front view of the same. Convergence of striae near the margins of the valves imperfectly shown in the figure.
- c.* Lateral view of the same.
- d.* Ventral view of expanded variety.
- e.* Posterior view of the same.

FIG. 5. *ORTHIS PECOSII*. (Page 125.)

- a.* Ventral view of an example a little above average size.
- b.* Dorsal view of the same.
- c.* Lateral view of the same.
- d.* Posterior view of the same.
- e.* Dorsal view of a smaller example.

FIG. 6. *CHONETES PLATYNOTA*. (Page 121.)

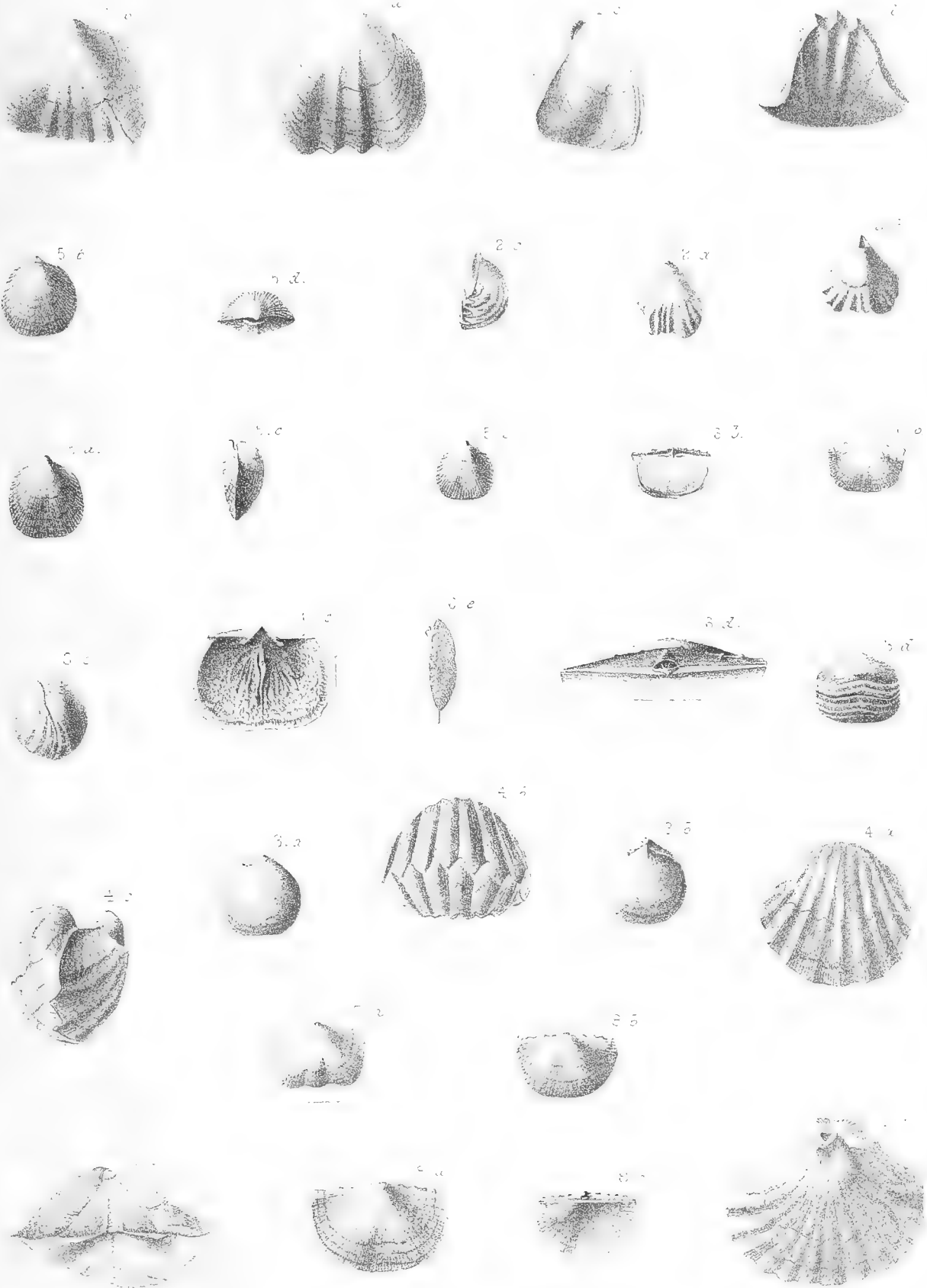
- a.* Ventral view of an averaged-sized example.
- b.* Dorsal view of the same.
- c.* Interior of a ventral valve, enlarged.
- d.* Posterior view of areas, enlarged.
- e.* Vertical section along the median line, enlarged.

FIG. 7. *CHONETES MESOLOBA*. (Page 123.)

- a.* Ventral view, enlarged.

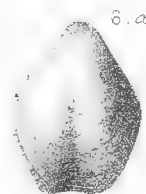
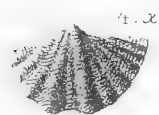
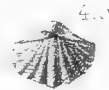
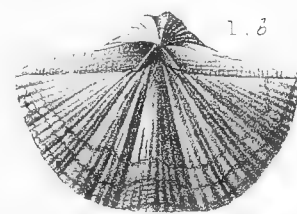
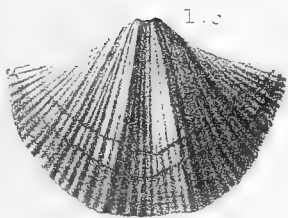
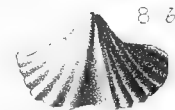
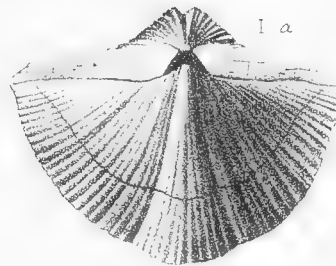
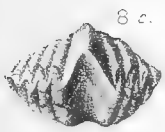
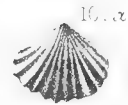
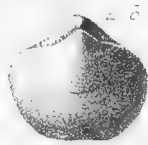
FIG. 8. *CHONETES GRANULIFERA*. (Page 122.)

- a.* Ventral view; hinge-line less extended than usual.
- b.* Ventral view of another example.
- c.* Dorsal view of the same.



EXPLANATION OF PLATE X.

- FIG. 1. *SPIRIFER CAMERATUS*. (Page 132.)
a. Dorsal view of an example from near Santa Fé.
b. Similar view of another example from Northern Missouri.
c. Ventral view of the same.
d. Lateral view of the same.
- FIG. 2. *SPIRIFER (MARTINIA) GLABER* var. *CONTRACTUS*. (Page 136.)
a. Ventral view of an example, near average size.
b. Dorsal view of the same. The specimen has been a little compressed.
c. Lateral view of a large example; a little distorted by growth.
- FIG. 3. *SPIRIFER (MARTINIA) PLANOCONVEXUS*. (Page 135.)
a. Ventral view of a specimen, enlarged.
b. Dorsal view of the same.
c. Lateral view of the same.
- FIG. 4. *SPIRIFERINA KENTUCKENSIS*. (Page 138.)
a. Ventral view of a specimen, enlarged; one hinge-extremity naturally longer than the other.
b. Posterior view of the same.
c. Dorsal view of another example.
- FIG. 5. *SPIRIGERA PLANOSULCATA*. (Page 143.)
a. Ventral view of average size of those contained in the collections.
b. Dorsal view of the same.
c. Lateral view of the same.
d. Dorsal view of another example.
- FIG. 6. *SPIRIGERA SUBTILITA*. (Page 141.)
a. Ventral view of an example of ordinary size and form.
b. Dorsal view of an example proportionally shorter.
c. Lateral view of the same.
- FIG. 7. *RETZIA MORMONIL*. (Page 141.)
a. Ventral view of an example of ordinary size.
b. Dorsal view of the same.
c. Lateral view of the same.
- FIG. 8. *SPIRIFERINA OCTOPLICATA*. (Page 139.)
a. Ventral view of an example a little below average size.
b. Ventral view of another example; test removed by exfoliation.
c. Front view of the same.
- FIG. 9. *HEMIPRONITES CRINISTRIA*. (Page 124.)
a. Dorsal view of an example somewhat compressed.
- FIG. 10. *RHYNCHONELLA METALLICA*. (Page 129.)
a. Ventral view, natural size.
b. Dorsal view of the same.
c. Lateral view of the same.
d. Front view of the same.



EXPLANATION OF PLATE XI.

FIG. 1. *AVICULOPECTEN COREYANUS*. (Page 147.)

- a. Left valve, a natural cast; the test wanting.
- b. Left valve of similar character, somewhat distorted by pressure.

FIG. 2. *AVICULOPECTEN M'COYL*. (Page 149.)

- a. Left valve. The example is incomplete, but the full size of the ears is either shown or indicated. The free border should be extended about one-third more for ears of that size.

FIG. 3. *AVICULOPECTEN?* *INTERLINEATUS*. (Page 149.)

- a. Left valve.

FIG. 4. *MONOPTERIA MARIAN*. (Page 151.)

- a. Right valve. Some examples show a little greater proportionate elongation, and some have the median angle raised into a distinct carina.
- b. Front view, showing lunule.
- c. Fragment of surface enlarged, showing striæ of growth.

FIG. 5. *PINNA PERACUTA?* (Page 151.)

- a. Fragment of the right valve. The outline shows the supposed shape of the whole valve

FIG. 6. *SCHIZODUS WHEELERI*. (Page 154.)

- a. Right valve, of about ordinary size. Natural cast; the test wanting.
- b. Left valve, in a similar condition.

FIG. 7. *BAKEVELLIA PARVA*. (Page 153.)

- a. Left valve, enlarged. From New Mexico.
- b. Left valve, enlarged. From Arizona. Probably of the same species as the other.

FIG. 8. *MYALINA?* *SWALLOWI*. (Page 152.)

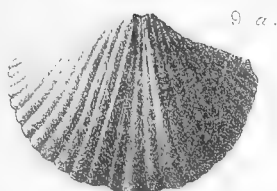
- a. Natural cast of left valve, natural size.

FIG. 9. *SPIRIFER ROCKYMONTANUS*. (Page 134.)

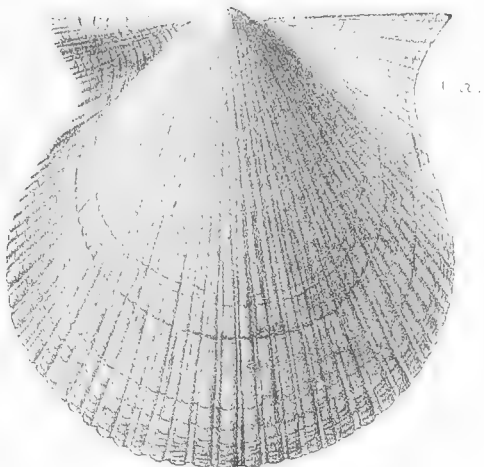
- a. Ventral view of a specimen of ordinary size.
- b. Dorsal view of the same.
- c. Lateral view of the same.
- d. Dorsal view of another example, having plications a little more angular.

FIG. 10. *TEREBRATULA (DIELASMA) BOVIDENS*. (Page 144.)

- a. Ventral view of more than usually elongate example.
- b. Dorsal view of the same.
- c. Lateral view of the same.



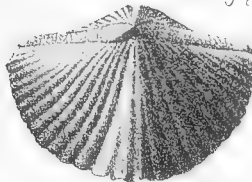
9 a.



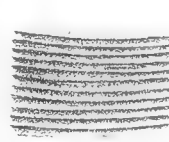
1 a.



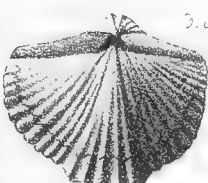
2 a.



9 b.



4 c.



3 a.



8 a.



6 a.



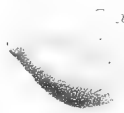
4 a.



9 c.



10 c.



7 a.



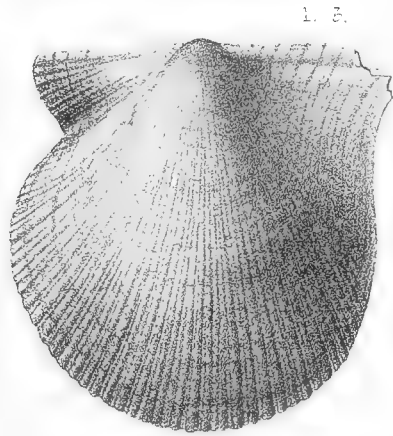
7 b.



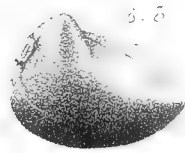
4 b.



10 a.



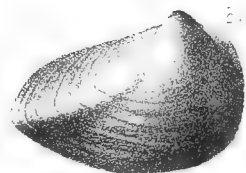
1 b.



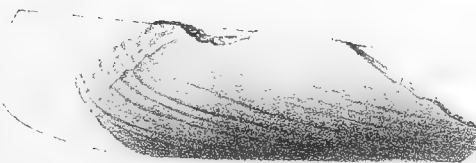
6 b.



10 b.



6 a.



5 a.

EXPLANATION OF PLATE XII.

- FIG. 1. *BELLEROPHON CRASSUS*. (Page 157.)
a. Dorso-lateral view.
- FIG. 2. *EUOMPHALUS PERNODOSUS*. (Page 158.)
a. View of upper side.
b. Umbilical view, showing the nodes.
- FIG. 3. *MACROCHEILUS ANGULIFERUS*. (Page 160.)
a. A large example, having the angle unusually prominent and distinct.
b. Another view of the same.
c. A smaller example; the angle less distinct.
d. Another example, with angle distinct.
e. Young example, in which the angle is hardly perceptible.
f. Another example, in which the flattened upper side of the angle is very narrow.
- FIG. 4. *NATICOPSIS NANA*. (Page 159.)
a. Example from Nevada.
b. Another view of the same.
- FIG. 5. *PLATYCERAS NEBRASCENSE*. (Page 159.)
a. An example from the typical locality in Nebraska.
b. Another view of the same.
c. An example from near Santa Fé, N. Mex.
d. Another example, with angle distinct.
e. Another view of the same.
- FIG. 6. *DENTALIUM CANNA*. (Page 156.)
a. A large example; the outline showing the supposed full form.
b. A mold of part of the surface, showing the minute longitudinal striæ.
- FIG. 7. *ALLORISMA SUBCUNEATA* var. (Page 155.)
a. Left valve.
b. Front view.
- FIG. 8. *AVICULOPECTEN OCCIDENTALIS*. (Page 146.)
a. Left valve.
b. Right valve. The specimen was imperfect. The body of the shell should be at least one third larger for ears of the size represented in the figure.



EXPLANATION OF PLATE XIII.

FIG. 1. *NERITINA* ? *PHASEOLARIS*. (Page 167.)

- a.* View of upper side of example of medium size.
- b.* Lateral view of the same.
- c.* View of the under side of the same.
- d.* Small example, showing the small fold against the spire.
- e.* Large example, showing the aforementioned fold, and also the obtuse revolving angle.

FIG. 2. *CAMPTONECTES* *STYGIUS*. (Page 164.)

- a.* Adult example, right valve.
- b.* Small example, interior of right valve.
- c.* Same, enlarged.

FIG. 3. *OSTREA* *STRIGILICULA*. (Page 163.)

- a.* Exterior of the deeper valve, natural size, showing scar of attachment.
- b.* Lateral view of the same.
- c.* Inside view of the same, showing parts about the hinge.
- d.* Interior view of the upper valve.

FIG. 4. *INOCERAMUS* *CRASSALATUS*. (Page 166.)

- a.* Right valve, the largest in the collections.
- b.* Another example, right valve.
- c.* Left valve, natural cast, showing the faint auricular furrow.

FIG. 5. *MYOPHORIA* *AMBILINEATA*. (Page 166.)

- a.* Right valve, natural size.
- b.* The same, enlarged.

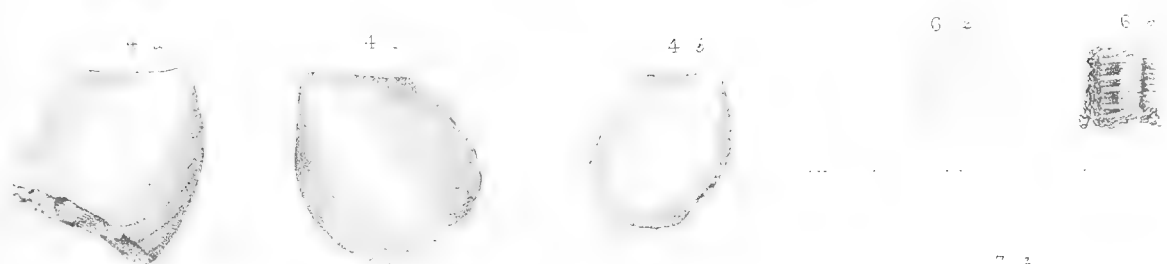
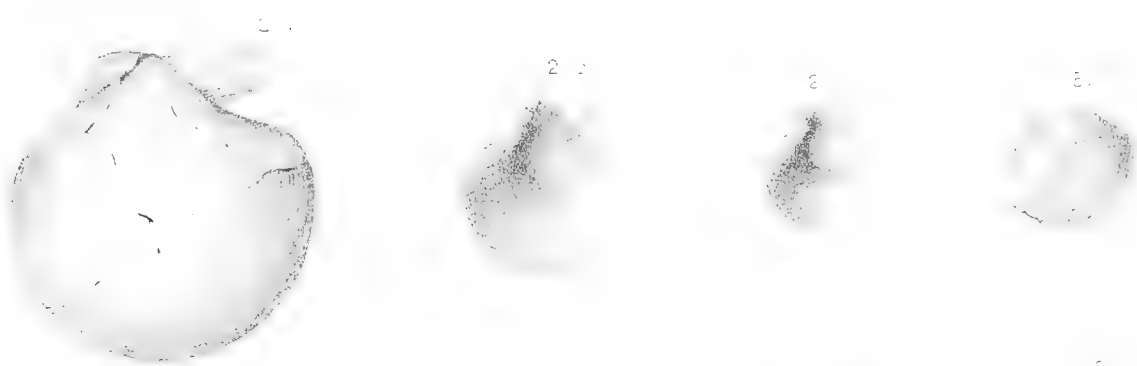
FIG. 6. *PENTACRINUS* *ASTERISCUS*. (Page 162.)

- a.* Articular face of a segment of the column.
- b.* Portion of a column, showing the alternating larger and smaller segments.

CRETACEOUS.

FIG. 7. *PINNA* *PETRINA*. (Page 182.)

- a.* Right valve, natural size.
- b.* Transverse section of the shell a little behind the midlength.



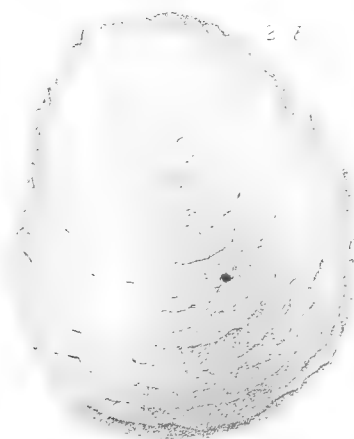
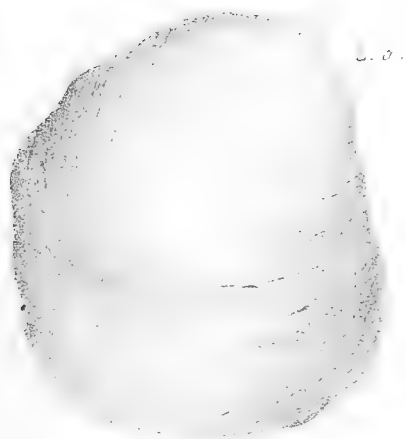
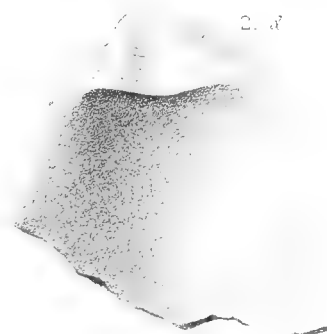
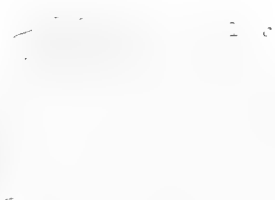
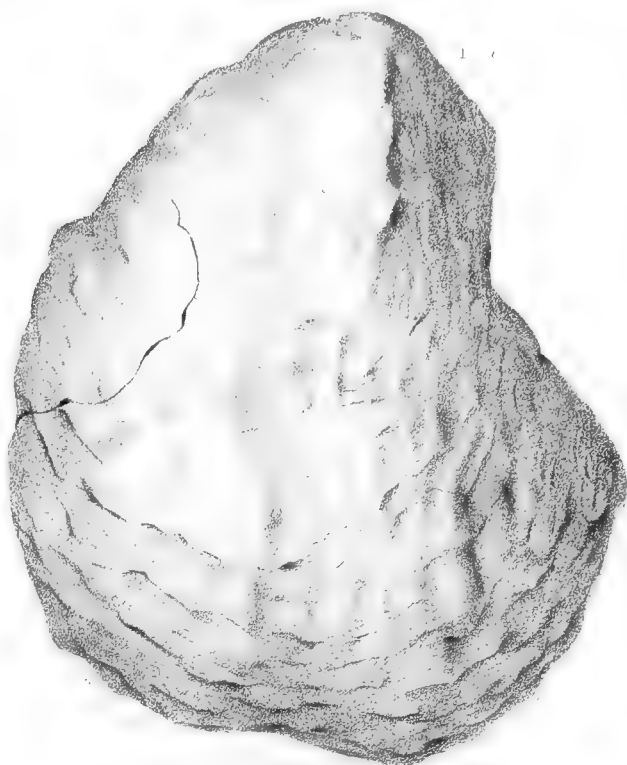
EXPLANATION OF PLATE XIV.

FIG. 1. *EXOGYRA PONDEROSA*. (Page 172.)

- a.* Exterior view of the larger valve; less than average adult size.
- b.* Interior view of the same.
- c.* Longitudinal section of the same, showing thickness of test.

FIG. 2. *OSTREA PRUDENTIA*. (Page 171.)

- a.* Exterior view, natural size, of the lower or more capacious valve, showing very small scar of attachment.
- b.* Exterior view of upper valve of the same, showing small prominent beak.
- c.* Interior view of upper valve.
- d.* Interior view of lower valve.



EXPLANATION OF PLATE XV.

FIG. 1. *INOCERAMUS DEFORMIS*. (Page 179.)

- a.* Exterior view of left valve, showing portion of the test.
- b.* Section of the test of a large example, showing its prismatic structure and great thickening at the borders.

FIG. 2. *OSTREA CORTEX*. (Page 170.)

- a.* Exterior of upper valve.
- b.* Interior of the same.
- c.* Interior of lower valve, showing hinge and area.

FIG. 3. *INOCERAMUS FRAGILIS*. (Page 178.)

- a.* Right valve.

FIG. 4. *LINGULA SUBSPATULA*. (Page 169.)

- a.* Dorsal valve.

FIG. 5. *SERPULA INTRICA*. (Page 205.)

- a.* Example, twice enlarged, showing unusual contortion.

1.6

3.d

1.2

4.a

5.

2.c

2.b

2.

EXPLANATION OF PLATE XVI.

FIG. 1. *INOCERAMUS FLACCIDUS*. (Page 172.)

- a.* Left valve, natural size, but some examples are larger.
- b.* Interior view of beak and hinge, right valve.

FIG 2. *INOCERAMUS DIMIDIUS*. (Page 181.)

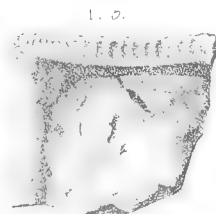
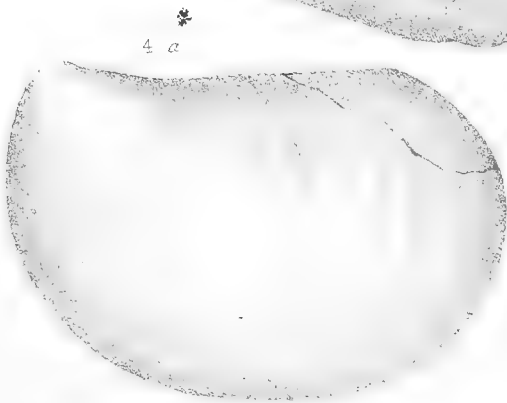
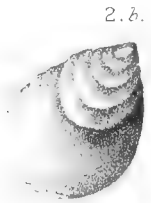
- a.* Left valve, ordinary natural size.
- b.* Right valve. Part of the shell without concentric folds.
- c.* Front view, showing convexity of both valves.
- d.* Left valve, showing unusually small concentric folds.

FIG. 3. *INOCERAMUS PROBLEMATICUS*. (Page 177.)

- a.* Left valve.

FIG. 4. *INOCERAMUS BARABINI*. (Page 180.)

- a.* Left valve.



EXPLANATION OF PLATE XVII.

FIG. 1. *GRYPHEA PITCHERI* var. (Page 171.)

- a.* Interior view of the convex or lower valve.
- b.* Exterior view of the same.
- c.* Lateral view of the same, showing the curvature.
- d.* Less elongate example of a convex valve.
- e.* Exterior of upper or flat valve.
- f.* Interior of the same.

FIG. 2. *EXOGYRA LÆVIUSCULA*. (Page 173.)

- a.* Lateral view of a moderately large example.
- b.* Inner view of a smaller example.
- c.* Lateral view of the same.
- d.* External view of the same.

FIG. 3. *EXOGYRA COSTATA* var. *FLUMINIS*. (Page 174.)

- a.* Lateral view of the largest example in the collection.
- b.* Dorsal view of the same.
- c.* View of the flat valve connected with the deep one.
- d.* Exterior view of small example.

FIG. 4. *LIMA WACOENSIS*. (Page 176.)

- a.* Right valve, natural size.
- b.* Left valve of another example.
- c.* Lateral view of the same, showing its convexity.

FIG. 5. *CAMPTONECTES PLATESSA*. (Page 176.)

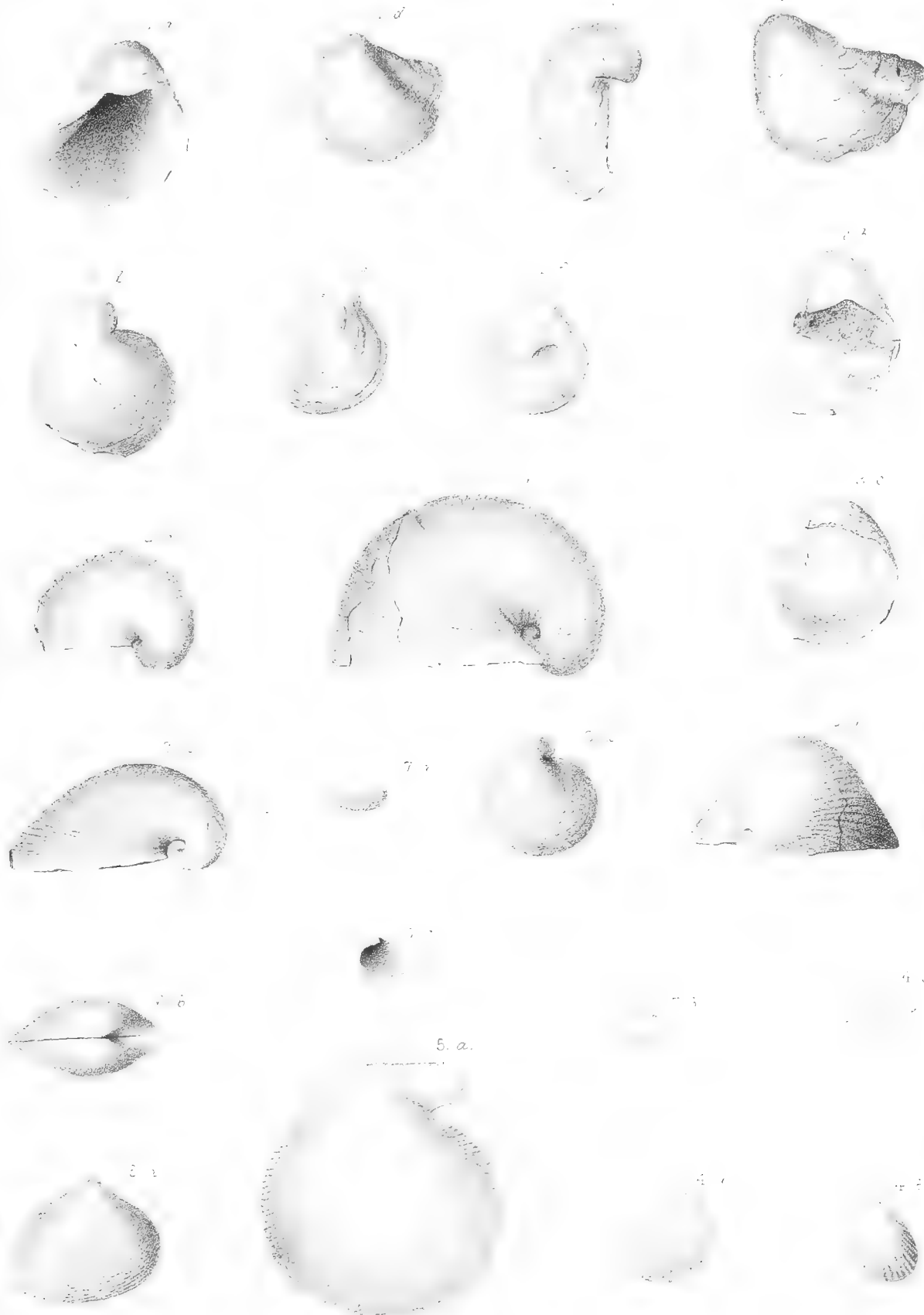
- a.* Right valve. The surface-markings mostly removed, and the radiating striæ a little too strong in the figure.

FIG. 6. *MACTRA*? *INCOMPTA*. (Page 185.)

- a.* Right valve, enlarged one-half.
- b.* Dorsal view of the same example.

FIG. 7. *CORBULA NEMATOPHORA*. (Page 188.)

- a.* Right valve, external view, enlarged.
- b.* Left valve, external view, enlarged.
- c.* Right valve, interior view, showing hinge.



EXPLANATION OF PLATE XVIII.

- FIG. 1. *CASSIOPE WHITFIELDI*. (Page 193.)
a. Lateral view, showing the umbilicus.
- FIG. 2. *LISPODESTHES LINGULIFERA*. (Page 192.)
a. Specimen enlarged; callus and test mostly exfoliated. This, however, shows the volutions of the spire and the posterior canal, which would otherwise be hidden.
b. Outline of the same, natural size.
- FIG. 3. *LISPODESTHES NUPTIALIS*. (Page 192.)
a. Specimen, natural size; test partially exfoliated.
b. Same, enlarged.
- FIG. 4. *ANCHURA? FUSIFORMIS*. (Page 190.)
a. Natural size; test mostly removed by exfoliation.
- FIG. 5. *ADMETOPSIS GREGARIA*. (Page 198.)
a. Natural size, showing aperture and folds of the columella.
b. Another example, enlarged.
- FIG. 6. *EULIMELLA FUNICULA*. (Page 197.)
a. Specimen, a little enlarged, showing aperture and straight columella.
- FIG. 7. *NERITINA (VELATELLA) CARDITOIDES*. (Page 189.)
a. View of upper side, natural size.
b. Lateral view of the same.
c. View of under side of the same, showing the broad inner lip.
- FIG. 8. *ANISOMYON CENTRALE*. (Page 194.)
a. Upper view of natural cast of the interior; summit broken off.
b. Lateral view of the same. The specimen has been somewhat compressed vertically.
- FIG. 9. *ANISOMYON BOREALIS*. (Page 193.)
a. Summit view.
b. Lateral view of the same.
- FIG. 10. *TURBONILLA (CHEMNITZIA) MELANOPSIS?*. (Page 197.)
a. Portion of the spire of an imperfect example.
- FIG. 11. *TURITELLA UVASANA*. (Page 195.)
a. Example of ordinary size, broken at both ends.
b. Portion of the surface of the last volution of the same.
- FIG. 12. *LUCINA SUBUNDATA*. (Page 184.)
a. Right valve.
- FIG. 13. *IDONEARCA DEPRESSA*. (Page 183.)
a. Right valve.
b. Dorsal view of the same example.
- FIG. 14. *LEIOPISTHA (PSILOMYA) MEEKII*. (Page 186.)
a. Natural cast of right valve.
b. Right valve, showing part of the fine surface-markings.
c. Left valve.
d. Front view of *a.*
- FIG. 15. *LEIOPISTHA (CYMELLA) UNDATA*. (Page 187.)
a. View of left valve.



EXPLANATION OF PLATE XIX.

FIG. 1. AMMONITES LÆVIANUS. (Page 201.)

- a.* Side view, the outer chamber partly broken away.
- b.* Portion of the plan of a septum.

FIG. 2. HELICOCERAS PARIENSE. (Page 203.)

- a.* Upper view of part of one volution.
- b.* Dorsal view of part of the same, showing double row of nodes.
- c.* Transverse section of the latter through the nodes.
- d.* A similar section made between the nodes.

FIG. 3. SCAPHITES WARRENI. (Page 200.)

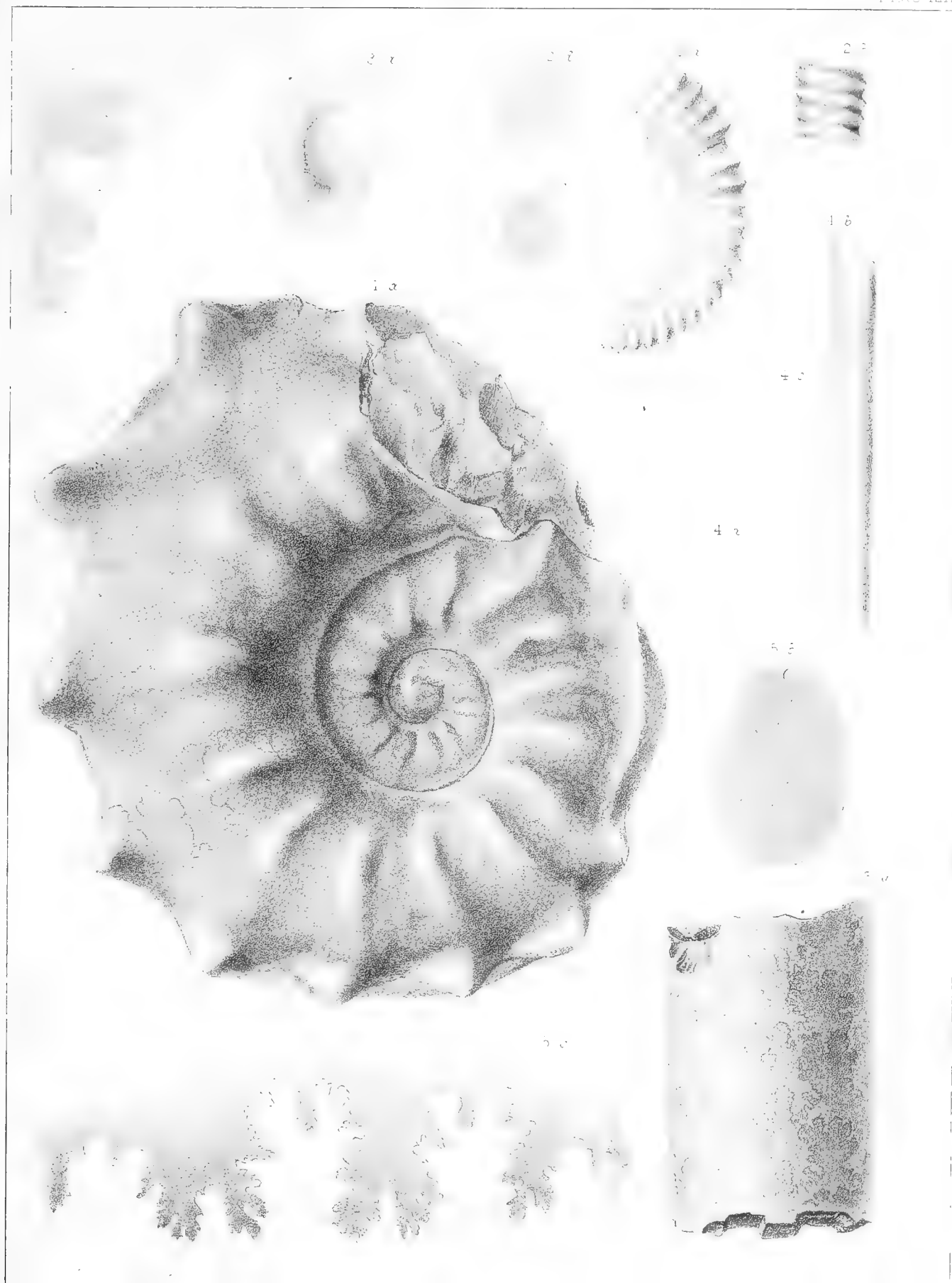
- a.* Imperfect example, showing only part of the last turn.

FIG. 4. BACULITES OVATUS. (Page 199.)

- a.* Outline of transverse section of outer chamber, near the last septum.
- b.* Small example from near Paria, Utah.
- c.* Transverse section of the same.

FIG. 5. BACULITES OVATUS var. (Page 200.)

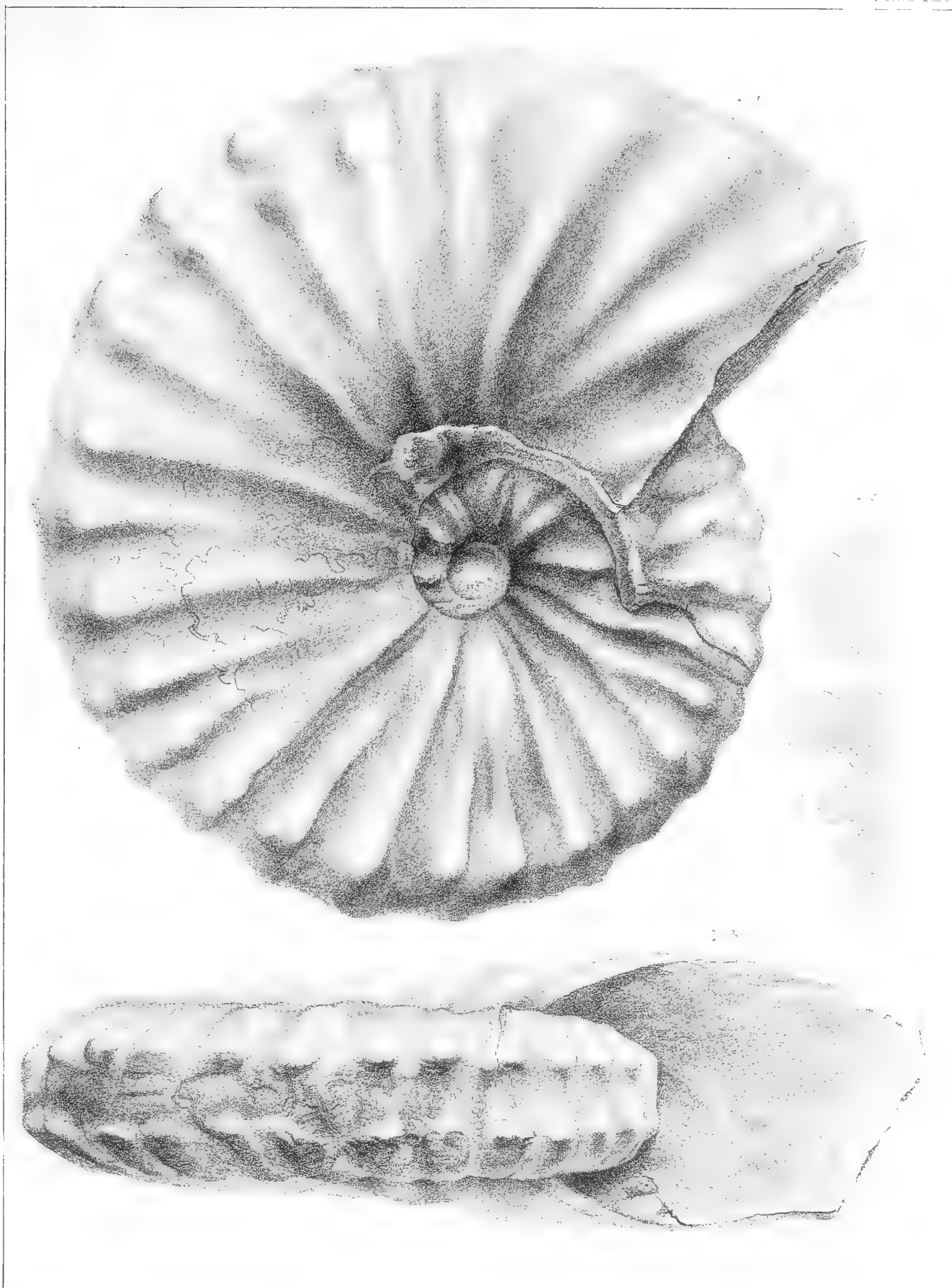
- a.* Fragment of the chambered portion.
- b.* Transverse section of the same example, about midlength.
- c.* Plan of one of the septa.



EXPLANATION OF PLATE XX.

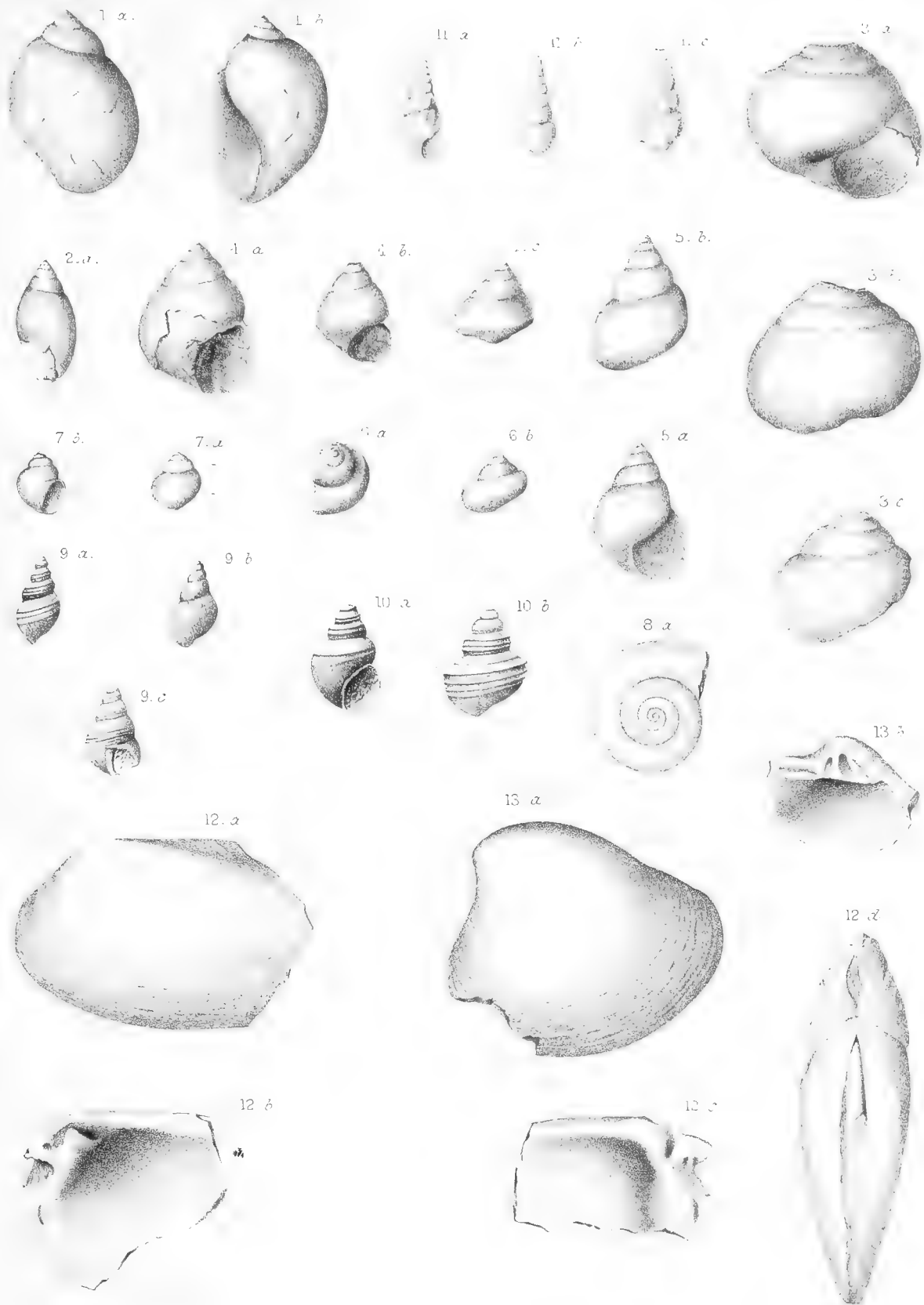
FIG. 1. *BUCINCERAS SWALLOVI*. (Page 202.)

- a.* Side view, full size, except that about one-half of the outer chamber has been broken away.
- b.* Front view of the same.
- c.* Plan of septum.



EXPLANATION OF PLATE XXI.

- FIG. 1. *PHYSA PLEROMATIS*. (Page 211.)
a. Example from Utah.
b. Another view of the same.
- FIG. 2. *PHYSA BRIDGERENSIS*. (Page 210.)
a. An example rather less robust than the typical forms.
- FIG. 3. *HELIX LEIDYI*. (Page 211.)
a. A natural cast, the test being entirely removed.
b. Another view of the same.
c. An example showing the surface-markings of the test.
- FIG. 4. *VIVIPARUS TROCHIFORMIS*. (Page 214.)
a. Typical form; a medium-sized example.
b. Another example.
c. Another, showing the apex quite complete.
- FIG. 5. *VIVIPARUS TROCHIFORMIS* var. (Page 215.)
a. Medium-sized example, showing aperture.
b. Opposite view of the same.
- FIG. 6. *VIVIPARUS IONICUS*. (Page 215.)
a. Upper view of rather small example.
b. Side view of the same.
- FIG. 7. *VIVIPARUS* ? ——— ? . (Page 215.)
a. Side view of example of ordinary size, enlarged.
b. Opposite view of the same.
- FIG. 8. *PLANORBIS UTAHENSIS*. (Page 209.)
a. Upper view of specimen, adult size.
- FIG. 9. *GONIOBASIS NEBRASCENSIS*. (Page 213.)
a. Example with revolving lines more than usually distinct.
b. Another example, differently and more faintly lined.
c. Another, still differently lined.—All natural size.
- FIG. 10. *GONIOBASIS TENUICARINATA*. (Page 212.)
a. Example with two carinæ. Also showing nearly full form of aperture.
b. Another with carinæ more than usually distinct and numerous.
- FIG. 11. *GONIOBASIS TENERA*. (Page 212.)
a. A complete example, rather less than average size.
b. Another similar example, opposite view.
c. Another example, full average size.
- FIG. 12. *UNIO VETUSTUS*. (Page 206.)
a. Left valve.
b. Interior, right valve.
c. Interior, left valve.
d. Dorsal view of a partially-crushed example.
- FIG. 13. *CYRENA (VELORITINA) DURKEE*. (Page 207.)
a. Left valve, ordinary size.
b. Hinge of right valve.



h w

~~1766~~ 1769

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 00892 7378